

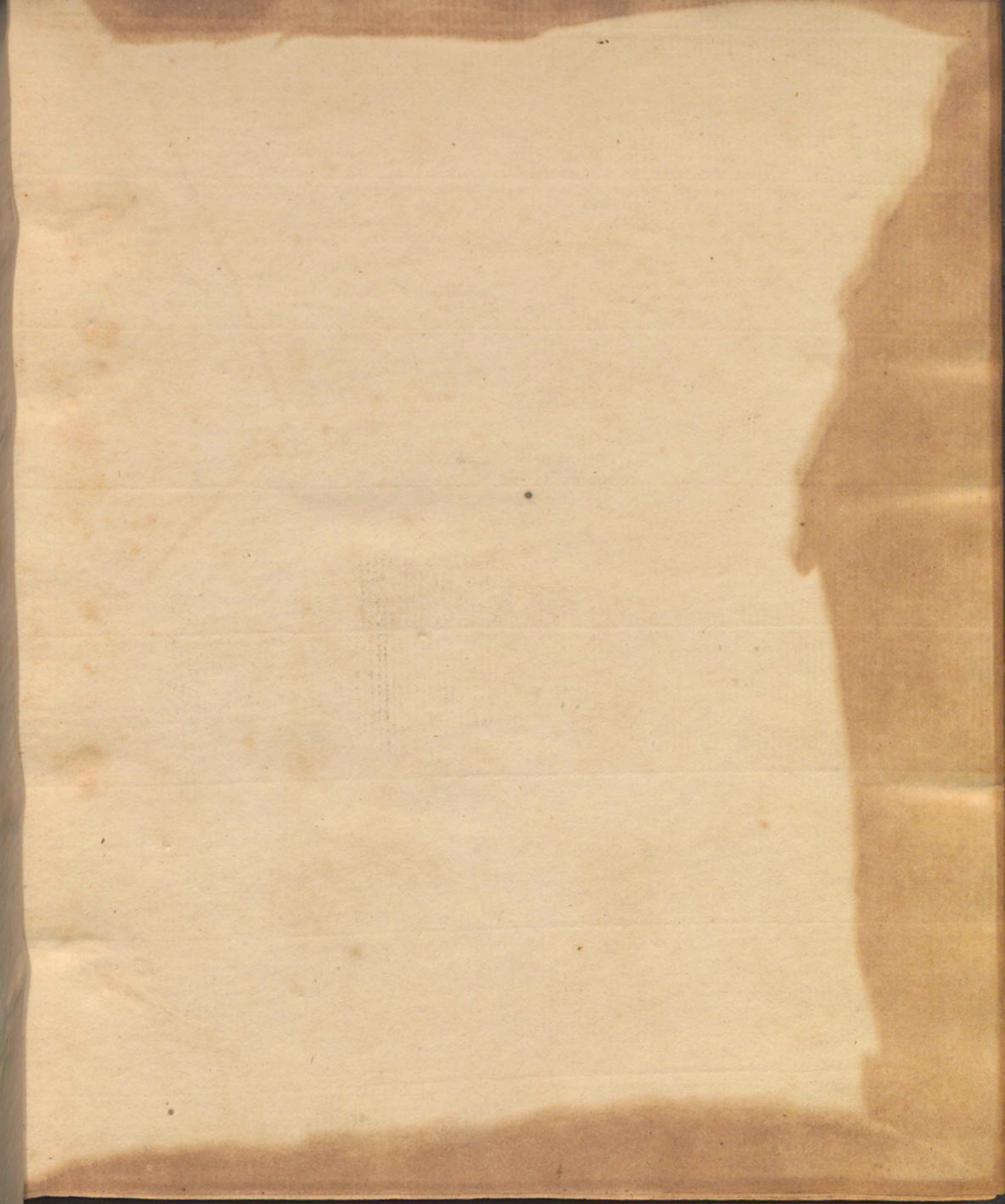
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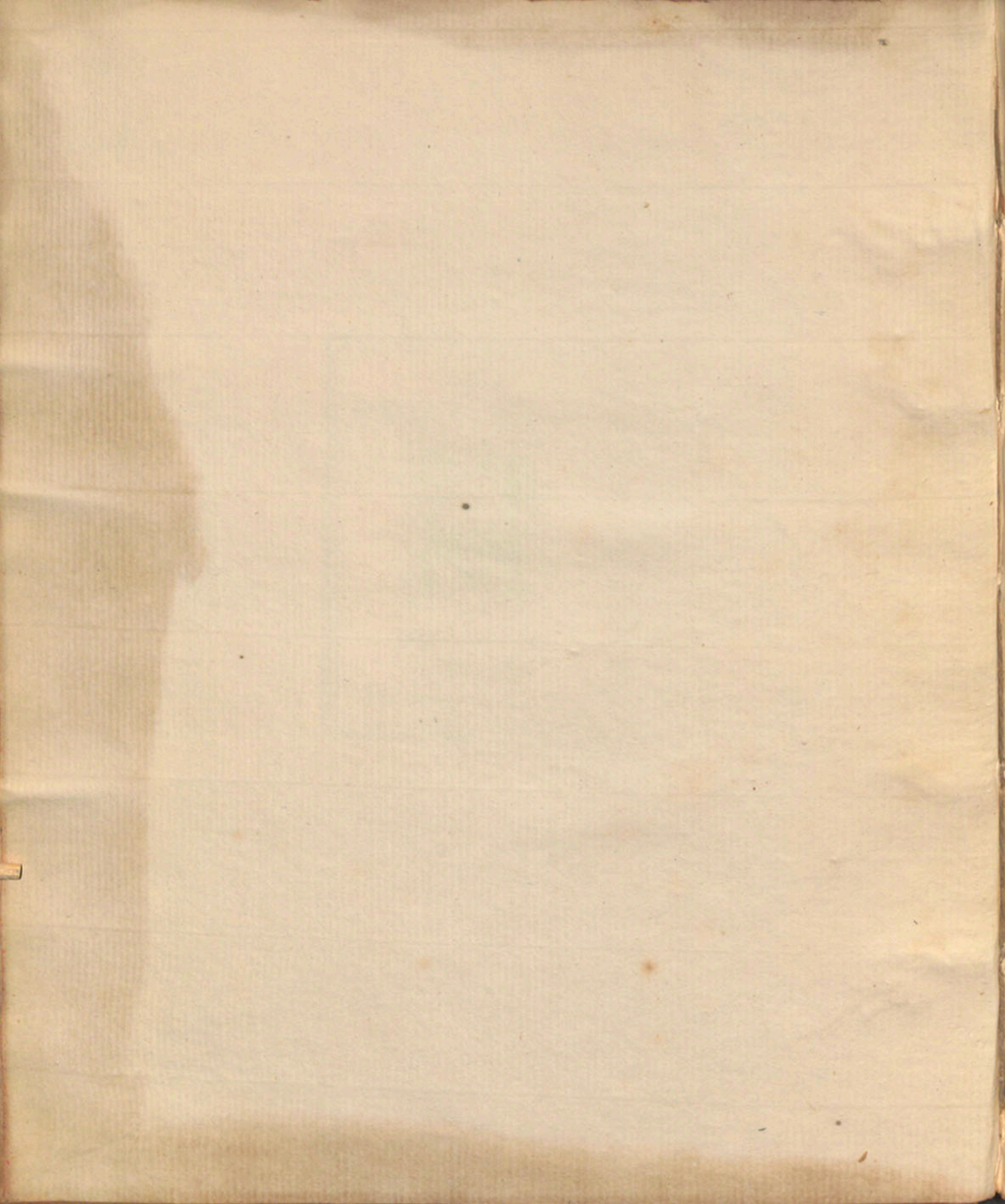
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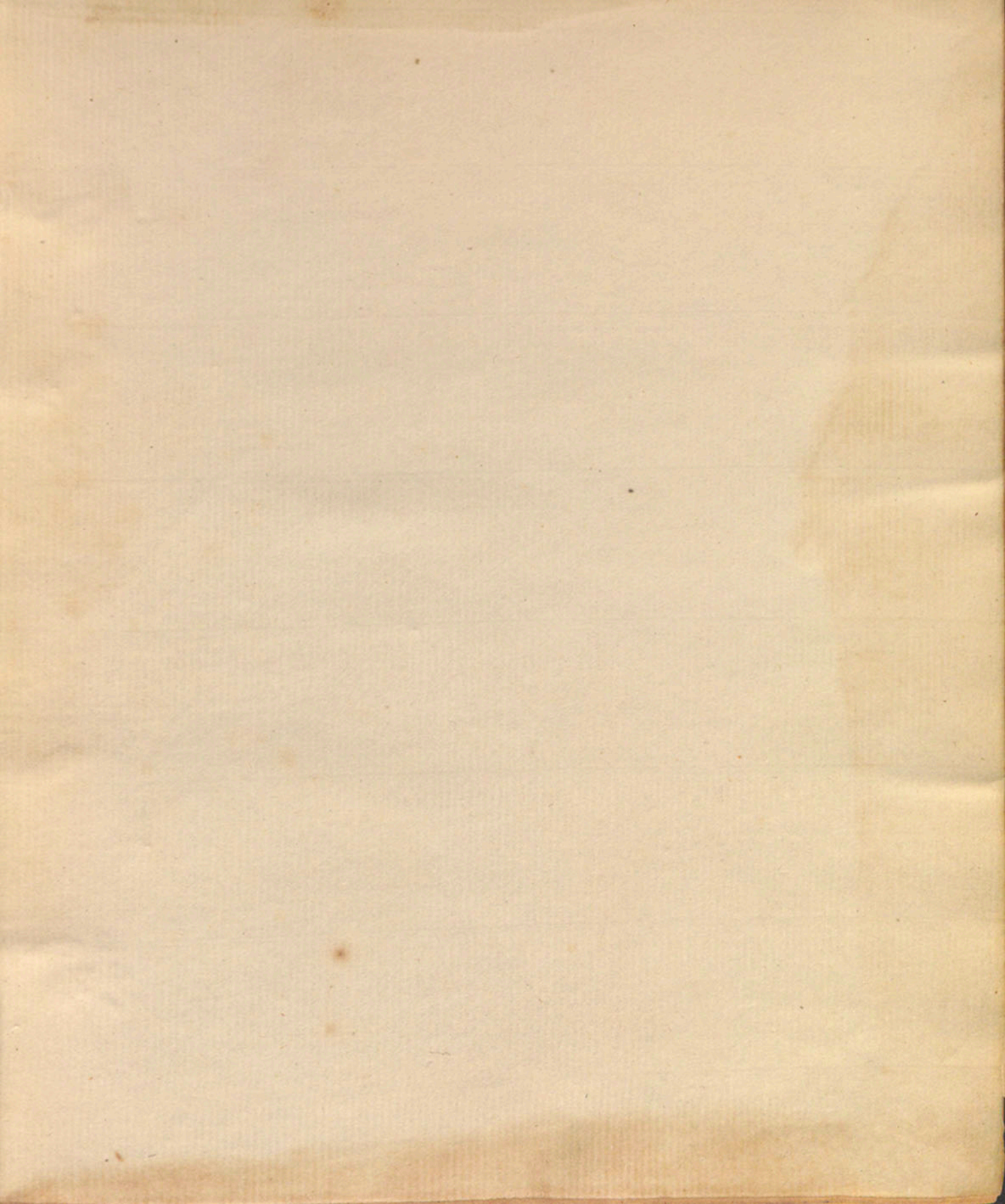
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Lectures
upon
the Institutions
of Medicine
by

William Cullen M.D.

Vol. 2.

Edinburgh 1768.
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Lecture

upon

the Constitution

of Medicine

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London 1763

Of the
Nervous System.

Part 2.



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Volume 2

Of the Functions of
the Brain.
Text
to the
Nervous System.

Of the Functions of the Brain.

XCVI. From the effects of Ligatures made on the nerves, or other means of destroying their continuity, it appears that in their entire state motions may be communicated from the Brain to other parts of the Nervous System, and also from the latter to the former; and from the same Experiments it appears that the Brain [II. 1.] is the Organ of Sensation and Volition as explained IX. 2. . This is confirmed by the effects of Organic affections of the Brain on the intellectual faculties.

XCVII. As Impressions made upon any part of the Nervous System are communicated along the course of the nerve upon which the Impression is made directly to the Brain, and hardly to any other part of the Nervous System but by the Intervention of that Organ; as 2^{dly} many Impressions thus communicated are by LXI not accompanied by Sensation or Volition and may therefore be presumed to be merely Mechanical; and as 3^{dly} these Mechanical Communications are variously modified by different conditions of the brain; it appears that the Brain is a corporeal Organ susceptible of various conditions and thereby of considerable

considerable Influence in most of the Phenomena of the Nervous System.

XCIII. The Brain seems by its Organization to be disposed to the alternate states of Rest and Activity, of Sleep and Watching; but wherein this Organization consists it is difficult to discover.

XCIX. Tho' for certain purposes of the Economy a fluid is secreted in the Brain, it does not appear that Sleep and Watching depend upon the state of this ~~secretion~~ ^{secretion}, or upon the less or greater quantity of such secreted fluid present in the Brain and Nerves.

C. Tho' a certain Compression of the Brain can produce a state of the System resembling sleep, this state is in some respects different from ordinary sleep, and it does not appear that natural and ordinary sleep depends upon any Compression of the Brain.

CI. As it is probable that Sleep and Wakening do not depend upon the different quantity of the Matter of the Nervous Power or upon any cause, interrupting its motion while the matter remains the same, it seems probable that these states depend upon the nature of the Nervous Power being capable of becoming more or less movable, and that it is especially in the Brain susceptible of

of those different conditions, and at least therewith more general effects on the whole System.

CII. It appears that a certain degree of Heat, the most part of Sensations, Impressions analogous, to those producing Sensation, and the Impetus of the Blood in the Vessels of the Brain are the chief causes of the moveable state of the nervous power in the Brain, and therefore of Watching.

CIII. It appears also that Cold, the want of Sensation and Impressions, Sedative Sensations & Impressions, Evacuations, Relaxations, the taking in of food, and all violent frequent or long continued Exercise of the Animal power diminish the moveable state of the nervous power in the Brain and induce Sleep. —

CIV. As most of those Causes CII. excite motion in the Brain and most of those CIII diminish it, it is probable from the Phenomena of Sleep and watching that the Nervous Power in the Brain is truly capable of different states or degrees of Mobility which we call its state of Excitement and Collapse; but this is without intending by these terms to express or determine any thing with respect to the nature of the Nervous power or wherein its different states consist. —

(CV. The

CV. The Excitement of the Brain appears to be in different degrees on different occasions. It seems to be greatest in certain Maniacs endowed with uncommon strength, resisting the force of most Impressions and the most difficultly admitting Sleep.

CVI. A second or lower degree of Excitement is the ordinary state of Watching in Men in health, when the Excitement is total with respect to the Brain & readily admits of Collapse or Sleep. But this Excitement may be in different degrees with respect to the rest of the System, and is expressed by Vigour or Debility, by Courage or Timidity, by Alacrity or Luggishness, and by Gaiety or Sadness.

CVII. A still lower degree of Excitement or the first degree of Collapse is in the case of Natural Sleep in which the Collapse takes place in the Brain so as very entirely to interrupt the Animal functions, but with the subsistence of the Vital and natural, only somewhat weakened. Even with respect to the Animal functions the Collapse is more or less complete as the Sleep is with or without Dreaming, and as the Dreaming is more or less active.

CVIII. A still greater degree of Collapse takes place
place

place in the case of Syncope, in which the Brain is so much and so totally collapsed as not to be sufficient even to the vital functions.

But we presume that there is still some degree of Excitement while the Brain can be acted upon by Stimuli that act only on the vital powers, and while its usual excitement is still recoverable by such Stimuli. If the Collapse is more complete and irrecoverable it is the state of Death.

That Syncope & Death are owing to causes which produce a Collapse of the Brain is probable from the nature of many of those causes & the circumstances of their operation.

CIX. It may now be observed that Sleep & watching do not depend so much upon the degree of Collapse & Excitement with respect to the whole System as upon these conditions being more or less complete with respect to the brain. But in assigning the causes of Sleep & watching we have mentioned the principal causes of the different states of Excitement in other respects.

It is proper in the next place to consider the different states of the other parts of the Nervous System which may be analogous to those of the Brain or may influence them.

CX. In the Nerves strictly so called, IV. 2. we do not know that

that the Nervous power suffers any change but what is exactly correspondent to the state of the same in the Brain, and the only difference to be taken notice of in the Nerves is their being more or less free or interrupted in admitting the communication of motion between their Origin and Extremities.

CXI. In the Sensitive Extremities of the nerves IV. 3. a different state arises from the several causes that we said before, XXXIX, 2, 3, 4, 5, might give a sufficient degree of sensibility & thereby determine the effects of Impressions communicated to the brain. Are not these different states of the Sensitive Extremities somewhat analogous to the states of Excitement & Collapse in the Brain?

CXII. The moving Extremities of the Muscular fibres, IV. 4. may also be in different conditions with respect to the Nervous power in them; How far this may arise from different circumstances in their peculiar Organization we are uncertain. We can perceive more clearly that their condition may be varied by the causes affecting the state of their Tonic power LXXXIII, LXXXIV, by the power of habit XCIV, & by their connection with topical Stimuli and in the case of the propensities XXII. Whilst they are causes that may affect any of the moving fibres it is to be observed that there are certain portions of them as the Muscles of voluntary motion, the Muscular fibres of the Arterial system, those of the Alimentary Canal & perhaps some others which are exposed to the action of peculiar causes

causes or to the general causes more than other portions of the same fibres.

Are not these different states of the muscular fibres also somewhat analogous to the states of Excitement & Collapse CIV & perhaps to those of the Sensitive Extremities CXIX?

CXIII. As almost upon every supposition there is a mutual pressure between the Origin & the several Extremities of the Nerves it is sufficiently probable that as the condition of either is changed it must produce some change in the other.

CXIV. The Excitement of the Brain is to be considered as of two kinds, one with respect to the Vigor, the other with respect to the Mobility, and this last with respect to Sensibility & Irritability may affect the one more than the other. These differences appear in age, Sex, & Temperament, & in the same person upon different occasions, and the conditions may be variously separated or combined, but the cases are difficultly ascertained & the causes are always obscure.

CXV. The action of the brain is excited not only by the causes of Excitement above mentioned directly but also indirectly or secondarily by the various causes of collapse.

CXVI. The action of the brain is determined & regulated by Custom & habit. See above XXVI, XXXVIII, XXXIX, 5, XLIII, XLIV, LII, LVI, & LVIII, 4, for the effects of custom on sensation. XCIV for one effect of the same on the action of moving fibres.

fibres. It is now to be observed further, 1st That custom determines the degree of Tension LXXXII that is necessary to the Action of moving fibres. 2^d That custom associates motions with certain Impressions not otherwise their causes. 3^d That custom associates different motions so that they cannot be separately performed. 4th That custom determines the order of Succession in associated motions, the velocity with which each is performed & with which they succeed one another. 5th That custom establishes the periodical return of certain motions not necessary to the Economy & fixes the exact period of certain motions wch by the Laws of the Economy are disposed to return at intervals. It will be obvious that in 2, 3, 4, 5, custom operates in determining & regulating the action of the brain.

CXVII. The action of the Brain is determined to particular muscles or moving fibres, 1, by Stimuli applied to certain parts ^{parts, that} producing no sensation. 2^d By Stimuli applied to certain ^{parts, that} producing no sensation but by a condition analogous or like to that which produces a sensation of consciousness. 3^d By a sense of pain or uneasiness arising from certain parts. 4th By the irritability of certain parts greater than that of others. 5th By a determination rendered more constant by Stimuli or habit. 6th By Irritation. 7th By propensity. 8th By Will.

CXVIII. The action of the Brain is withdrawn from certain parts or ceases with respect to them by causes contrary to some of these, & it is often interrupted by causes interrupting the Communication of motion from
from

from one part of the Nervous System to another.

CXIX. Most of the Communication of motion between the different parts of the Nervous System which have been mentioned as instances of a particular Sympathy between those parts, may as we think be better explained by supposing a general action of the Impression upon the Brain, and that the particular effects are owing to the causes of determination or withdrawing CXVII & CXVIII than by supposing any local connection between the Nerves of the parts impressed and acting either in their course or origin.

CXX. These are the chief laws of the Nervous System; they might perhaps be further illustrated and further ascertained by a more particular enquiry into the nature of this System & the causes which operate in it, but we are not so confident in our opinions on this subject or of the application they will admit of as to deliver them here. —

Finis

Functions of the Brain
Of the
Nervous System

* The Numbers refer to the Text, and what follows
are Comments on, or Explanations of, the several Heads.

A

We come now to consider the
Functions of the Brain.

* XCVI. The whole that is intended in this proposition is to confirm what is generally received among Physicians, that there is a *Sensorium commune*.

The first proposition is that in this System of ours we know of no Operation of Bodies on one another but what must be considered as a communication of motion from one to the other—thus if I cut a Muscle out of the body with a portion of a Nerve adhering to it & touch the Nerve with a Needle I thereby produce contraction in the Muscle. I conclude here that there is a Mechanical communication of motion by a continuation of matter from the Nerve to the Muscle, & that the Needle cannot act on the distant muscle but by a communication along the Nerve, and this Experiment will equally hold in any length of Nerve we can apply to it, and therefore when on any part of a Nerve adhering to a muscle I put on a ligature, & find the effects which did before, yet do not now take place, I conclude the communication is interrupted.

With

With regard to its operation at the other Extre-
mity of the Nerve. If I touch the other Extremity of
the Nerve & produce Sensation I say it is from a
motion excited, but if I put a ligature between the
puncture & the brain no motion ensues, hence I
conclude that motion is excited in some other place
than the place of contact. If I remove the Ligature
Sensation returns, but if in any part I apply a
Ligature between the Brain & the part Stimulated
no effect follows, but if I puncture in any part be-
yond the Ligature nearer the brain Sensation is con-
sequent upon the Stimulus, and nothing destroys Sen-
sation without the communication to the Brain is
interrupted. Compression of the Brain as it is ana-
logous to ligature affects Sensation in the same
manner. Motion hence is produced & may be pro-
pagated from any given point of a Nerve to the ex-
tremities, & from thence to the Brain. Ligatures &
other means of destroying the continuity of the Nerves
destroy the continuity of Sensation. Many Physio-
logists have admitted a motion along the course
of the Nerves, but have confined it that it was
one way in the Sensory & another way in the Motory,
but Anatomy shows us no distinction in these
Nerves, they are the same Nerves wrought up in
the

the same fasciculus - the same is a motory & a
sensitive nerve at the same time, we have instances
of a puncture producing contraction and sensation
at the same time; no body doubts but the Impres-
sion acts on one nerve only at the same time, there
is no doubt but the motory nerve is capable of
motion in both directions. With regard to the
Sensory nerves, that motion is communicated from
the extremity to the origin is evident; but whether
the contrary of motion communicated from the
origin to the extremity takes place, is not so
evident, but is I think equally certain, as in the
simple Experiment of tickling the lip with a feather
where after the lip has been once tickled the
imagination supplies the same sort of motion -
& in the communication of pain & shrill external
sounds producing sensation in the teeth - Whatever
Theory you adopt this must be evident that there
is a certain portion of Sensory Nerve along the course
of which the pain is returned. There are then
nerves fit for the communication of motion
from the brain to any part of the Nervous System,
and it is only there they can be supposed to have
a continuity, and it is this that forms & unites
the nerves into one System. I before observed that
Sensation

Sensation & Volition unite impressions & actions, & these are functions of the Brain & of the brain alone. The proof of this perhaps is not necessary, but to obviate cavil we have given a proof - as no operation in the material world but proceeds on a communication of motion, if a body has effects on a distant body 'tis by the continuity of substance uniting distant parts, and this motion propagated by a continued substance is successively impelled or propelled from one part to another; the proofs of this I have just now mentioned - in another view it is Sensation & Volition that unites various Impressions.

Impressions on the brain excite Sensation and Motion, and compressions on the brain analogous to Ligatures will interrupt Sensation & Motion in all parts of the System, & Volition or any Stimulus in the Brain excites the contraction of Muscles. Sensation & Volition belong solely to the brain, & never operate but when the brain is free & undisturbed, & any ligature or compression interrupts Sensation & the effect of Volition.

If Sensation and Volition are operations of the Brain, & that only go on there, all intermediate functions are functions of the brain so far as they depend

depend on corporeal matter. It has been said that the Integrity of the Nerve must be supposed or the communication won't take place, but often the integrity is not affected when Sensation & Volition are interrupted, thus they are stopped by Ligatures without any interruption of the integrity of the parts, whether you suppose the Nerves to be chords, tubes &c., it is trifling to say the integrity of the Nerve is necessary, for if a Nerve be cut thro' it does not interrupt Sensation & motion in the parts connected with the brain, on the contrary it performs its functions excites muscular contraction as well tho' some what weaker than before. It is confirmed by several other considerations, by organic affections of the Brain - all considerable affections of the Brain affect Sensation & interrupt the intellectual faculties, as contusions, abscesses, compressions &c., very frequently on removing these organic affections as splinters of Bones &c. all the intellectual faculties return as before, such external violence only operates in this manner, when applied to this organ the brain. The same causes do not produce similar effects in other parts of the system; Arms, legs, &c. may be cut off without affecting the intellectual faculties

faculties. These facts we can't take so well separate because the affections of this Organ can be communicated to other parts, but the intellectual faculties are only disturbed when we can observe the continuity of substance between the parts affected and the brain. When the heart is hurt it affects the Brain, but it is in so far as the distribution of the blood affects the head, this however is different in different Animals, Sedatives & Narcotic Remedies only affect the intellectual faculties, by a communication to the brain. The Torpedo by a slight stroke benumbs the hand & if stronger it affects the intellectual faculties, we conclude that the effects produced are only in consequence of affecting the Brain directly or by communication.

The effects often appear when the causes are not evident, as the intellectual faculties are often disturbed without or knowing the cause; all such are accompanied with Inflammⁿ of the brain, a peculiar humidity flaccidity &c. which appear on dissection, especially those of the Vesania which accompanies these Organic affections. Sometime the Anatomist cannot discover any affection, but the Brain is an Organ we know only grossly & hence it may have a structure affecting our intellectual

intellectual faculties that we are not acquainted with; there are some changes that have been taken notice of within these 10 years, that there may be a change of density with which there is a change of the intellectual faculties.

The degrees of dryness &c are such as have escaped the search of any Anatomist. If other intellectual faculties depend on the state of the Brain, Memory must more especially. Take a number of cases from Haller to this purpose.

If Memory depends on vibrations in consequence of Impressions, or if on a peculiar organization any thing corporeal, (with I much doubt) but if there is the least foundation for this they are certainly in the brain alone & not in the organs of sense - for we have instances of Memory ^{re}main^{ing} after the organ which first produced the sensation was destroyed, instanced in Homer, Milton &c retaining their Ideas of sight - so many persons retaining their memory of music in an exquisite degree when quite deaf. - All sensations of Consciousness arising from the state of thinking we refer to the Brain - we do not refer our sensations of Consciousness of Impression to the particular parts precisely but in an inaccurate manner

240. Haller Tom IV. P. 356.

ner, e, g, of difficulty in respiration to the Thorax, the ailments of the heart, as inaccurately, of the Alimentary Canal to the Abdomen &c. but we conclude that such affections arise from changes in the Organ, it is the same with memory attended with uneasiness constantly referred to the head.

All these seem conclusive in favour of our doctrine, but one doubt may be raised that many animals live without brain, or at least with petrified or ossified Brains.— This seems to furnish an argument of the inutility of the Brain, but such objections do not lie so strong as they may seem, the facts themselves being often not true or inaccurate. You will find sufficient instances of this being owing to the inaccuracies or mistakes of Anatomists. Again this is taken from particular Animals, & it is difficult & improper to apply it to all. In many as the Insect tribe it is not lodged in the head, for many of them live with their heads cut off. Birds have their functions less dependant on the brain than in any other animals of warm blood. We are not obliged to explain why more or less of the vital functions prevail, and in another why more or less of the
animal

Animal do. If one Animal lives sometime after its medullary substance is cut out, we must not conclude it with respect to others. In the Amphibia it is less dependent than in those of warm blood, motion in them remaining after the head is, totally separated from the other parts. In all sorts of Animals we may be mistaken in supposing the functions solely dependant on the brain. Nature has taken care that the functions of the body sh^d not depend on single powers as it depends also on Arteries, Veins, Lymphatics &c; hence if a part is destroyed there is still enough remaining for the support of the whole. This is no where so striking as in the Nerves, no part has its nerves from a single source, & probably every Nerve comes from a different part of the brain. It is very possible that every part of the body has its Nerves both from the Encephalon & Medulla Spinalis.

These facts may affect the Italian Doctrine in so far as it is connected with one part of the System, as they suppose an intellectual faculty always connected with the vital; but it cannot affect that which supposes Vitality in many cases to be purely Mechanical, & little connected with the intellectual faculties. The proofs of
Animals

Animals being with disordered brains does not hurt it, nor in the least affect our doctrine, as in all these cases the intellectual faculties were disturbed. (for this see Haller in the above cited place).

This remains pretty certain that the Brain when taken as an Organ comprehends the Medullary Substance. I w^d not limit it as many Physiologists have done to particular parts. Lancisi & some others have confined the sedes cogitationis to the corpus callosum, there is however no proofs of this but on the contrary facts tending to refute it. There is one conjecture that has some probability, that the intellectual operations seem more especially to be ~~more~~ connected with the Incephalon in Man & our creatures. The Nerves of 4 of the senses do terminate there, & there is likewise probability that the Nerves of the Organ of Touch have likewise the same termination in that Organ.

Whatever opinions we form here become fundamental with respect to Physiology & the Animal Economy, hence we should consider well what determines our next step. It enters so much into the Animal Economy that many & various opinions have been formed & maintained. Some may be such firm Philosophers as not to enter upon any opinion
-on

on, but I believe the generality cannot resist entering or adopting some or other of them. We shall examine them all & conclude with or reject them as we find occasion.

I began with the brain as the corporeal organ of sensation & volition; this is incompatible with the Hallians System. Our first Argument was drawn from the effects of ligatures upon the Nerves, whence we found that no sensation arose unless by motions communicated to the brain.

2. There is no volition but in consequence of motion begun in the brain & propagated along the Nerves. Sensation is the beginning of thought, & volition its alternate effect, comprehending all the different intermediate degrees. — Any disorder of that Organ is constantly attended with disorders of the intellectual faculties, this is not only probable but actually the fact, from the Argument immediately preceding. Has the brain any precise limitations as the intellectual Organ? No extent but the beginning of the Nerves. Some have assigned different intellectual faculties to different portions of the Brain. These have been however long rejected, but some as Lancisi have lately confined it to the corpus callosum, but there are

are none of these opinions but are embarrassed with strongly contradictory facts, and hence I would reject any precise limits. I offer it as a conjecture that the operation of thinking seems much confined to the Incephalon in man or such like Animals. With respect to Touch there is no part sensible but has it's Nerves from the Brain, they also arise from the Medulla Spinalis & more than one part of the brain, hence most nerves of sense are united in the brain, and if we suppose their connection depends upon somewhat corporeal, here we must suspect continuity which is necessary for such communication, and if we observe how the Medullary substance is intermixed we shall find that there is not any eminence that has not it's fibres from the surrounding parts. This gives some probability that so far as these are corporeal they are connected by means of this communication in the brain. The Medulla Spinalis does in fact seem less concerned than some have imagined, as lesions have happened with the intellectual faculties remaining entire. Lesions at it's origin have it is true proved fatal, but at the same time the intellectual faculties remain

(see

Haller. Tom IV. P. 338.

ed entire. The opinion with respect to an intellectual brain is attended with many difficulties, among which are that we have instances of lesions of the Brain well ascertained, in which any disorder of the intellectual faculties did not occur. There are many instances that wd seem to stagger us. I don't say how many of these instances adduced are to be rejected, how many by reasoning are to be obviated; I will say that after all they are only a very few exceptions to a general Induction. When we have established the Brain to be the Organ of sensation & volition it is but in part corporeal. How far they are to be universally considered in this way, or whether at any time it be not corporeal solely we come now to consider.

XCVII. You know the Stahlans & Dr Whytt do not allow this.

1. The Brain is a means of corporeal communication, there is little communication between the other parts of the Nervous System but what is corporeal. Dr Whytt's notion of no communication taking place but by means of the brain has been extended too far but is in general true, for this you must take as an example all sympathies between distant nerves.

Nerves. For the Brain is the means of Communication between these.

2. When we have advanced that many of them are by means of the Brain only, I proceed to this 2^d part of our proposition. It is very allowable that many Stimuli that excite Muscular Contraction are not accompanied by any Sensation or Volition. — The same of the Blood vessels.

3. Whilst the Brain forms a communication we find that to many of these Mechanical Operations are superadded a modification that we will suppose does not only arise from or by a communication there, but requires modification in consequence of which the action resulting is different. The same causes produce various effects according to the different states of Sensibility. In Maniacs the same Impressions have very different effects from what they have in a sound state.

When I observed that an Impression made on a part of a Nerve does communicate motion to a part at a distance from that Nerve, it gives no difference of Sensation, it is only a continuity — I have observed that the Brain is in some measure a means of this continuation, but when I find that the effects of this puncture on the Nerves, on the Muscle

Muscle is very different from the first Momentum on the Nerve, it cannot be, merely by communication that these effects take place, some latent powers must be excited, in the same manner as in Gunpowder set on fire by flint & steel. Such is the case I say with respect to Muscular motion, & such the Modification in the Brain with respect to Impressions made on it. as a corporeal organ it may have considerable influence on the impressions made on it, these impressions being varied by different conditions of the Brain we can hardly refuse the conclusion.

I mean to enquire whether the corporeal communication be accompanied with Sense or Volition, & if even in these a corporeal volition does not take place. Boerhaave does not suppose there is the smallest progress, in thinking that it is not accompanied with a change in the Brain - This perhaps may be too much but there is certainly a corporeal modification accompanying it. Gaubius in Par. 523 is more explicit. I have before said that this may be received and maintained without affecting other opinions, with respect to the Soul, & it is only in this way that Physics can be put on any proper footing. - It is only in so far as Man is a corporeal System that we can reason about him.

We may with Boerhaave consider the State of the Soul as given and speak of the Brain as the only part we can enter upon.

SCVM. It is extremely inconvenient to be loose in this respect & to mix a Stahlian & mechanical System together which will inevitably produce confusion. Boerhaave's System is of this kind, whether he ~~allows~~ ^{allows} that nothing mental comes under our consideration but in so far as it is connected with the body yet on certain occasions does he admit the reasoning of the Stahlians which will quite destroy the other part of his system, thus in the 1st part of 579 de causis somni — & this is a doctrine purely Stahlian.

The explanation of Sleep & Waking is attended with many difficulties, & I don't believe it is yet successfully accounted for, but by enquiring into these two very frequently recurring states of sleep & waking I think we may discover some very steady principles respecting the functions of the brain, the common distinctions of sleep & waking are very insufficient for this purpose. These two states the one of rest the other of activity of our Animal functions, & to what degree these take place we must refer to an after consideration.

The

The first thing I would say is that such is the nature of the Animal Economy as to be disposed to this alternation. In larger Animals when we can better observe them it is in common to them once in 24 hours to alternate their states of Sleep & waking, it does not alter the position that there are instances of some mens being kept awake for several days & then sleeping for as many, as this is only one instance among 10000. It is a law of the Economy with great exactness, with regard to the state of watching giving a disposition to sleep, for if waking be by Stimuli protracted to a certain length, sleep will return at last in spite of them, or else will induce such disorders in the system as to put an end to life, of which we had instances in the barbarous practice of keeping people awake for witchcraft.

There is more dispute with respect to the spontaneity of waking. We commonly suppose that waking is owing to the effects of Stimuli applied. There are many instances that if you can keep Stimuli from people they will sleep much longer than their usual time, & some people from the force of habit have been able to make their whole lives almost

almost one continued state of Sleep. Our body is never without Stimuli, the very remaining in one posture after a certain time will prove a stimulus, & the natural functions too that go on will also, prove a Stimulus, we therefore cannot be certain that waking is spontaneous.

If it be proved that Sensation & Motion are functions of the Brain we shall not doubt but that Sleep & waking depend on the alternate states of that organ. I began with considering the tendency there is in these two states of alternating with each other, & hence we may conclude that it is a general law of the Economy once in 24 hours - One looking into the causes of watching & tendency to return to sleep it is true that we find the ordinary returns can in some measure be prevented, but beyond certain limits they cannot be stopped without fatal consequences to the System.

There is another way that Sleeping produces waking that I did not take notice of before, viz, a sensibility to impressions w^{ch} would not have operated at the first beginning of Sleep, but after that sleep has been protracted to a certain length, a person may be awakened by still slighter stimuli,
here

here Sleep does in a manner produce waking.
In case of habit there is a kind of spontaneity of waking.

XCIX. This is one of the most prevailing opinions & at first a specious one, it is that there is a fluid accumulated in the Brain, a defect or abundance of which are the causes of Sleep or watching - that it is wasted by the exercise of the body, & this deficiency is the cause of sleep during which this fluid is again secreted & accumulated.

This affects the Nervous System more strictly, it was the opinion of Boerhaave who had taken particular pains to prove this secretion, & to establish it, by insinuating that the Brain had a secretory apparatus. If there be a secretion there is a fluid distributed by the Nerves, now on this subject various disputes have arisen among Physiologists.

The whole labours of Boerhaave on this subject turn on there being an appearance of a secretory apparatus in the brain, a peculiar distribution of the blood, a peculiar structure in the extremities of vessels - to corroborate this he accounts for the nature of secretion, adopts the Pyeotican & rejects the Malpighian Theory, but it was objected that tho' the
brain

brain has the appearance of a secretory organ, yet no fluid hitherto has been discovered secreted, to obviate this he adduces some corroborating circumstances, some forcible, others frivolous & superficial.

I with Boerhaave admit the fact that there is a fluid secreted in the brain & from thence distributed to all parts of the body. I conclude it because nutrition is performed by the nerves which are the primary fundamental staminal parts of the body from which all parts originally proceed & to whom all subsequent secretion & growth of the system is manifestly owing. (but this we shall have occasion hereafter to consider) — I admit then of secretion, but sleep & watching & the phenomena of the nervous system are not to be ascribed to this fluid or the motions taking place in it. It is true that if the only functions of the Brain were sense & motion we might be induced to think so, but when we find another function, viz, Nutrition, performed by means of a secretion, it is more probable that the fluid thus secreted will be employed in this only. In vegetables there is undoubtedly a nutritious fluid passing along every fibre, and we find these fibres moveable & irritable, in the manner in which the nutritious Juices in Vegets are carried along

along their fibres, or even in Animals makes the supposition of another fluid for the vehicle of Sense & Motion more necessary, as the nutritious fluid cannot perform functions so very different. I join with Boerhaave in the supposition that if nutrition is performed by the Nerves it must be by an aqueous albuminous fluid & such a fluid is inelastic & unfit for the motions that occur in sensation & muscular contraction. It is well known that the celerity of every motion propagated thro' Air or Water is in proportion to the density of the Medium - there is no reason for supposing our nutritious fluid to be rarer than water, but suppose it 100 times rarer still it is unequal to the velocity with which Sense & Motion are propagated, & far short of the Mobilisimum that Haller speaks of in the Nervous fluid; several have adduced calculations for this purpose, & have computed the velocity to be at the rate of 30,000 Milesⁱⁿ a second, but as Haller justly observes calculations are inaccurate & proceed on uncertain data, but he says that from actual experiment it cannot be less than 9000 feet in a minute - it cannot be less than this, but it is probably more, and such velocity can't be supposed to take place in any fluid we are acquainted with in nature

Gaub. P. 187.

nature. Hence it is that almost all Physiologists imagine that such velocity cannot take place but in a fluid highly elastic. In the present age many are seeking for the same kind of fluid as air, the Electric & Magnetic fluid, & light, & by reasonings drawn from the analogous effects of these either supposing them identically the same with the Nervous fluid, or resembling it from a variety of circumstances. I am disposed to suppose it a fluid sui generis, of a peculiar nature, & Gaubius is nearly of the same opinion but is cautious in making any determinate conclusion, but it is easy to see his propensity, as he asserts it to be so extremely subtle as to escape our senses, & proposes as a Quære whether it is not the Electric fluid? an Electric? & in another place he says potius subtili cuidam fluido debeat inherere. I say that there appears to be an Elastic fluid in the nerves of Sense, that sensation remains after the Impression ceases to act, & this can only take place in Oscillating bodies. The Vehicle of Sense & Motion in wch the quick motions take place cannot be the aqueous inelastic fluid that Boerhaave speaks of, it neither the nutritious nor a secreted fluid of any kind whatsoever,
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we cannot possibly conceive that a permanently elastic fluid can be produced by any secretion, nor if secreted that it can be ^{confined} in the nerves as hollow tubes. Boerhaave however adduces an Argument that the fluid may be secreted and distributed in a state of vapour, & hence the fluid in the nerves may be in an elastic state. This is not improbable but this state of Elasticity which depends on heat only is not compatible with the phenomena of the Nervous System, with the duration of Irritability; it is true that irritability ceases soon after life, & seemingly with the heat of the parts, but I say it does not cease so soon, as if it was dependant upon heat alone, as if only by being supported in a state of vapour. The mobility & Activity of the Nervous fluid is much connected with Heat, other Elastics, as Air, is so, where the Elasticity is so permanent as not to be destroyed by any degree of Cold yet known. The Nervous fluid may be less permanently Elastic, & sooner affected than Air by a diminution of heat, & altho' we know of no degree of Cold that diminishes Elasticity, yet it may be very different in this respect in different Animals, much less in the Amphibia than in others
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of warm blood. It subsists in Fish & Amphibia, in a heat nearly approaching to the freezing point, & Dr. Martin has observed that fish are but a degree or two warmer than the medium they swim in, but this is a degree of heat too small to keep any Animal fluids in a state of vapour, & there is a great difficulty to support any opinion we can conceive with respect to the warm Animals having their nutritious fluid in a state of vapour. There are some instances adduced in support of it, that in warm Animals the great heat appears necessary, yet the irritability of the Muscular fibres takes place in a less degree of heat than these Animals could live in. Again they say that cold does not entirely destroy the Elasticity of the Nervous fluid, that fishes can be brought to life after being frozen, that the vitality of many Animals is not destroyed tho' the heat necessary to the motion of the Solids is diminished. All this however depends on the manner in which the cold is applied - all the Amphibia can possibly be brought below the freezing point. Hence an Elastic fluid depending on being in a state of vapour cannot be the vehicle

Vehicle of Sense & Motion & consequently it is not
the nutritious fluid, but neither is it a secreted
fluid, for if it be confined within hollow tubes,
especially if an elastic fluid it must endeavour
to escape whenever these fibres are cut thro'
but it does not subsist after these are divided
in several places. I think this is a circumstance
agt^t its being an Elastic fluid contained within
vessels, at the same time I must say it is agt^t
any Elastic fluid - be it so I am not concerned
for any particular Hypothesis - it does not af-
fect the opinion of Dr. Gaubius who supposes
it is an inherent in its own nature permanent-
ly elastic, but I take no charge of this or
any other opinion, I am only concerned in re-
futing the notions of a secreted fluid.

With the opinion of a secreted fluid there is
a necessity of its flowing constantly into the
nerves & greater at one time than another, & into
the muscles under contraction - all these opini-
ons are necessarily connected with each other -
Haller has [in Tom. IV. 565] enumerated all the
different opinions. He acknowledges however
that

that none of them are satisfactory, to the disposal of the superfluous Nervous fluid. With regard to any opinion we can take of a fluid in the Brain, and that being liable to waste by Muscular motion is inconsistent with the motions of muscles cut out of the body & cut into several pieces. It is by means of a fluid produced only in the brain is by no means compatible with the motion of muscles cut to pieces, any opinion therefore of a secreted fluid is incompatible with the phenomena of Sense & Motion.

Neither is it compatible with Sleep & waking as I said at first, it is well accounted for by such a fluid's being alternately wasted & accumulated - but this is merely Hypothetical without the least evidence of such a wasting being made. All Dr. Haller's Arguments for the vis insita are applicable agt. it, but at same time if my Arguments agt. him were valid, they will all apply for the independance of the Nervous power. There is besides no evidence of its Accumulation. In other parts of the body where this is the case we see receptacles, but no body has suspected that such are produced in the Nervous system - it is true

true that in several instances of other secretions there is no receptacle provided but only an accumulation in the excretories which admit of a considerable dilatation, as in the Mamma, but there is not the smallest evidence for this in the Nerves, no appearance of such occasional distension & collapse. I know it is no Argument against the Nervous fluid, it's not being affected by ligature, shewing intumescences by an obstruction & partial accumulation of the fluids, that this is inconclusive appears in Vegetables, wh shew no intumescence tho' we are sure of the existence of a fluid, but it is a good Argument ago! it's being collected in unusual quantities at one time & so far drawn off at another time as to occasion a remarkable emptiness or collapse. There is no evidence therefore of a constantly repeated & retained secretion in the brain, the conclusion is Theoretical as founded on a supposition of alternate waste & accumulation, but if we admit this alternate effect we cannot pretend to assign any probable cause for it.

We shall here recapitulate some part of what has been before said.

We have first considered Dr Boerhaave's opini-

on & some others connected with it. The Arguments we employed against were some more some less conclusive, but the matter must be determined by reducing the whole into one connected view. It is generally received that the motions of the Nerves depends on a fluid constantly present, and if we discover a fluid it has been concluded that such a fluid is the vehicle of those motions we take place in these Nerves. Boerhaave has endeavoured to prove a fluid present in the Nerves in consequence of a Secretion in the Brain. But it doth not follow that this fluid is the vehicle of Sense & Motion but on the one supposition of their serving no other purpose, for if it be found that the Nerves perform their offices it is possible that this fluid is appropriated to these, viz, Nutrition & this alone, for Nutrition is performed by the Nerves, and because the Nerves are thus the Organs of Nutrition it is necessary that there sh^d be a fluid for Sense & Motion different from that of Nutrition.

It cannot be that this Nutritious fluid can be adequate to the functions of Sense & Motion as this must be an inelastic fluid which is by no means

means adapted to the velocity with which these are performed - as all Philosophers have agreed that it cannot be an inelastic fluid, & some have thought of an Electric fluid &c. but here many difficulties occur otherwise it wd be adequate to the solution of the Phenomena. I think there is some proof of an Elastic fluid being present, but we shall not insist upon this at present.

An Argument may be adduced in favour of Boerhaave's opinion by supposing this fluid to be in a state of vapour, but this is incompatible with the duration of Irritability &c. There seems to be a connection with heat, but with such a heat as has no effects in volatilizing any animal fluids we are acquainted with, as some Animals live tho' near the temperature 32 Degs and in some they are restored even after they are frozen by the application of a proper degree of heat - but if it be a secreted fluid and in an elastic state it must be confined in hollow tubes which is by no means agreeable to our observations on this head, as on cutting them it wd immediately desert & escape them - I think this affects every supposition of an Elastic fluid - It must especially affect a secreted fluid

fluid that is connected with a motion of a constant supply that is communicated from the Blood without any connection with the Brain more than as it derived from the Arteries.

It doth not affect Dr Haubius's opinion, who thinks it permanently Elastic & sui generis in the same manner as Magnetism is always inherent in Iron - I now go on farther to observe on the opinion of a secreted fluid, that tho' at first it may seem very well to account for Muscular Motion, yet what embarrasses every Theory that takes in an accessory fluid is to determine how that accessory quantity is taken out on the relaxation of the Muscles. But if it be liable to waste I can think of no opinion that is reconcileable to the irritability of Muscles long cut out from the body, detached from the brain, & divided into several pieces - hence I infer that a secreted fluid is not compatible with the Phenomena of Sense & Motion.

I now go on to observe that it is not compatible with Sleep & watching; this seems tolerably well accounted for by supposing the secretion of a fluid during Sleep, and its dissipation by watching.

ing, exercise &c., but this is not founded on fact,
purely Hypothesis - I have given reasons why
there is no evidence of a waste of this fluid by Mus-
cular motion, for if such a fluid be introduced in-
to the Muscle how is it carried off, there is no way
for such a fluid to get out again. But with respect
to the inherent power in the Contractions & Relaxa-
tions it is rather perhaps a difference or change in
the matter than any thing brought in or taken away,
therefore all Dr. Haller's Arguments that wd apply
to the independance of the inherent power will for
our reasons apply to the independance of the Ner-
vous power. How the Nervous fluid by thinking
&c. is wasted there is not the smallest conjecture -
There is no proper evidence of the means of accu-
mulation wch this Theory requires - there are
none such as in other parts of the System where
such an Accumulation is made, for there is no
receptacle for such, no evidence of any distension
taking place occasionally in the nerves. If such
were there is reason to believe that such would
take place on the application of a Ligature, but
no appearances are seen except such as may be
accounted for by the blood vessels being accidentally
inclosed

included. I shall next proceed to observe that there is no evidence of any inequality taking place in the secretion of the brain, but that the notion is purely Theoreticall & made up in consequence of the other opinion.

Some have thought of the erect posture diminishing the quantity of blood to the head, but some people are continually almost confined to their beds, & brutes are never erect. Evacuations cause sleep & hence have been supposed to do this by diminishing the secretion in the Brain; but the effects that take place on any Evacuation are too sudden to have any effect on a secreted fluid. Fullness of Stomach causes sleep too, this is likewise too sudden to have any effect on secretion, & sleep & watching keeps no correspondence with the increase or defect of nutrition, but we shall speak farther on this head in a subsequent Lecture. In general people that live fully are most disposed to Sleep, and those that live on a spare diet are not so much so, the contrary of which should follow as their secretions are less. When a man has used much labour he is drowsy, they may say it is for want

want of the secreted fluid, but a Stimulus will equally supply its place. — There is no occasion for supposing a supply of matter because these Stimuli are often purely Mechanical. It may be said it acts by encreasing the secretion, but at least it does not do it by encreasing the action of the Heart, for fear will prove as great a Stimulus as Anger — a Stimulus may take place for several days, which we cannot suppose to be the case if the fluid were exhausted in 24 hours.

When the returns of Sleep become by habit periodical, when a person's usual turn comes on, if the sleep be put off for half an hour or so the watching may be protracted to an unusual time.

If watching depends on the quantity of fluids secreted after a sound Sleep, a person should remain awake for a long time, but supposing the Nerves now quite full if he be not engaged in a train of thinking or stimuli applied, such a person will fall asleep again &c. Watching then is often compatible with an emptiness & sleep with a fullness of the Nerves. The returns of Sleeping & waking may by turns become periodical. It is true that other functions can be rendered in some measure periodical

periodical to return in quantity at very regular periods, it is a return of sensation that is governed by laws peculiar to the Nervous System, & very different from what take place in the Hydraulic system. I have been frequently without making water from Morning to Night, but have always a habit of doing it at going to bed. Now if by any unusual drinking I am obliged to empty my bladder a little before I go to bed, yet the wonted Micturition will recur at the wonted time tho' the quantity sh^d be perfectly inconsiderable. It is possible likewise to render the evacuation by Stool periodical, but the quantity will be varied by circumstances. It is the same with the brute creation — you may observe that Cows in a pasture will very punctually (without any enumeration of the time that we know of) return at the same hour to the gate they used to be milked at, both in Summer & Winter (when there is a great difference as to the quantity) & even tho' they have been robbed of their milk but a little before, here the usual stimulus of quantity cannot take place — but it is the quantity by their supposition that ought to have the influence in Sleep & waking. — Labour & Exercise are means of producing sleep

Sleep, but this is not at all conclusive unless it can be shown that it can be in no other way produced. Sleep will return at the usual period when the labour has been inconsiderable & even none at all - none of them show that Sleep & waking depend on the quantity of fluid secreted. It may be said that by motion the fluids become so fit as to be unfit for secretion, & on waking there may be a certain tenor & viscosity in the fluids that renders them unfit for that purpose, but this is mere hypothesis, & from what has been said it is probable that a fluid secreted in the brain is not concerned in the business of sense & motion, & the phenomena of Sleep & waking cannot depend on this cause, we must seek then for some other, viz, Compression.

C. This may produce something like Sleep, but supposing it is like ordinary & natural Sleep it is not to be supposed that Sleep ordinarily proceeds from Compression - the same effects may proceed from different causes, Vomiting is produced by acid matter introduced into the Stomach, but a distension of that Organ with warm water will produce the same effect.

Again, Compression does not produce genuine sleep, the difference however I am at a loss to establish, I
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can point out only one, viz, in the degree of excitability - very moderate Stimuli will commonly produce ~~exciting~~ waking & prevent sleeping, but in an Apoplexy no Stimulus we are acquainted with will produce waking. In cases where we find the patient inexcitable by Impressions we conclude there is some Compression of the Brain; but we neither know the causes that could give Compression nor any that could remove it. I hinted before that the erect posture of men (as diminishing Secretion) according to Boerhaave &c might produce Sleep, but this is directly contrary to Compression, & the horizontal posture in Brutes totally excludes it, and if a man should fall asleep in this posture he ought never to awake again according to them till in an erect posture, but there is no proof of any distension of the vessels in sleep, rather the contrary, & compression is by no means the ordinary cause of sleep; this opinion has not been often maintained, & I shall on that account desert it here without farther discussion, however we may have occasion to speak farther of it when treating of the effects of opium.

(C. The)

CI. The reasonings here are by no means conclusive, & they endeavour to raise an Argument (ad absurdum) that as it is not in any of the former it must be in this only which remains; but it seems to depend on none of those. There may be circumstances relative to the operations of our internal motions entirely unknown to us. It may possibly not be improbable that Sleep & waking are merely a change in the condition of this matter, but this is an opinion not at all founded on facts, a mere Hypothesis, I offer it with great caution.

CII. According to my view of the matter the common doctrine so long established in the Schools of Physic is by no means satisfactory. I endeavoured to shew you that the notion of a secreted fluid is totally incompatible with the phenomena of Sense & Motion, neither do we perceive that the interruption of the communication of motions in the Nervous System depend on Compression of the Brain or on any powers analogous to this, since therefore none of these are found sufficient I offer my own that it is probable it depends on some change in the condition of the matter, and this we shall find probable from farther consideration.

1. Heat

1. Heat. a certain degree I say higher than in Sleep, this I chose to limit, because possibly there is still a higher degree that will produce Sleep. If heat be necessary to life, & all its exercises, & when these may be in different degrees, & if waking be a higher degree of vitality than Sleep, then heat may be in a particular degree the cause of Watching. We shall best understand the Argument by considering that certain degrees of cold extinguish all the exercises of Life, & it is well known that in the progress of its operation its first effect is to produce Sleep; this is a fact well established by observation, that cold in killing Animals first produces Sleep, this therefore is an intermediate state in opposition to watching, a diminution of the vital powers of the System which going on in life ceases altogether. Observe the effects of Cold in different Animals, in some it produces only Torpor as in Serpents, in others it produces a constant sleep, the vital functions still remaining, in some degree, as in the Dormouse &c; but in some it goes so far as to produce a cessation of all the actions of life, as in the Bat, Swallows &c; Perhaps it still leaves the Animal solid unchanged, as all these Animals were recoverable

recoverable by a certain degree of heat. In sleeping Animals it has been found that the external Air does not diminish their heat, but that it is diminished by their being in a state of Sleep simply. Good heat restores them we have an instance in Leuwenhoek, where in the transparent wing of a bat there was a small globule seen wavering backwards and forwards, being concreted till its fluidity was restored by the action of the Solids, which must consequently have been the first restored - hence the restoration of life does not depend on the restoration of secretion to the Brain, no, heat finds something in the Muscular fibres whereon to act, perhaps this is analogous to the beginning of life. It is only by the Muscular fibres being set in motion that the distribution of the blood & the various secretions can take place - some have thought that heat gives the real matter of the nervous fluid.

The next set of causes are the most part of Sensations, no matter whether sedative or not, most part of our Sensations are Stimulant - There may be indeed a supposition that certain causes of Sensation may communicate matter to the nerves, but the greatest part of them are merely Mechanical, and hence there can be no supposition of their

their communicating a particular matter. Sensation only takes place in the brain, and the motion may operate by exciting a sensation constantly going on in that organ; this supposition may be made, & therefore I have added Impressions analogous to Sensations. I have only in view to add & mention these instances of the Activity of the Inherent power, as in the case of muscles cut out of the body, there is no accessory power, by motion alone it can be communicated, and tho' I opposed the particular opinion of Haller as to the *vis Nervea* when he supposed it a Stimulus I combated it only in so far as it might lead to a difference between these matters; if merely by a communication of matter the *vis insita* can be rendered active, I see no reason why motions from the extremities to the brain may not act in the same manner.

I go on now to the last cause, viz, the increased impetus in the vessels of the Brain. Whether this may not in certain circumstances produce sleep I shall not enter upon, but nothing is more certain than that fever does produce watching, and this in proportion as the determination to the head is more or less evident - more especially it produces it when
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the Impetus of the Blood is more especially directed to the Brain—Secretions are frequently little augmented by the Impetus of the blood in the vessels of a Gland, but I will not employ it as sometimes the contrary happens, & this you will say may happen in the Brain. But if there be any foundation for a nutritious fluid being secreted in the Brain this ought to be, but we are certain that it is not increased in the fever.

But observe that I have just now said, that merely motion communicated excites the contraction of the inherent power in all the Muscular fibres. The extension of a Muscular fibre has also the same effects, and indeed the activity of muscular fibres depends on a due degree of Tension. In the Nerves of Sense the Mobility of the sentient extremity does depend on Tension & is increased by it.

From all these considerations it is highly probable that the active state of the ^{in the} brain depends on a state of Tension given it, this is confirmed by every circumstance we can enter upon, we cannot find that an increased impetus augments, or a diminution lessens it. When one pound of blood is drawn from a person in health I think it cannot be supposed to affect the

the secretion in all the glands. — I shall not enter here upon deviation & revulsion, but it is very difficult to make the brain be immediately or sensibly affected, the distribution is very soon restored to the whole system in its ordinary proportion. If the evacuation produces sleep I cannot think it does it by diminishing secretion, it cannot so suddenly diminish a secretion that is capable of accumulation. If a person faints in blood letting a small difference in the position of the body will obviate the effects that would otherwise ensue, but the gravitation of blood to the head cannot be supposed to affect secretion in so momentary a way.

CIII. With respect to Cold we can hardly suppose it acts otherwise than by withdrawing the quantity of heat or diminishing the Mobility — we are led to this from the different degrees of Mobility dependent upon Cold.

Want of Sensations & Impressions — you must take this in certain ways, the want of accustomed Impressions serve to prevent sleep as we often find in changing our bed. The vital functions are not interrupted during sleep because they produce no sensation, but when exerted in an unusual degree they do produce sensation, hence we may conclude that

that the brain is an organ whose functions depend on being kept in motion.

The Brain is still an organ of secretion, but does it require a constant Stimulus to continue the secretion? Some have alledged that it does. I don't know any secretion that requires a constant Stimulus, hence the circulation will supply the want of Stimulus in a certain degree. Tho' there may be circumstances ~~which~~ ^{one} determine the blood to particular parts at ~~more~~ ^{one} time more than another, as in the secretion of Milk from the breast, there is no reason to suppose a Stimulus constantly applied to the gland. It is true that in some instances if the Stimulus ceases to be applied the secretion will also cease, but this is never suddenly. I take the last instance of a woman giving suck - if the child be taken away so that there is no exertion, the secretion will then not take place, but this is not immediately, the secretion will go on for some time by reason of the circulation. The falling asleep from want of Sensation and Impression is by no means analogous to the want of Stimuli more or less steady than usual. The want of Impressions may suspend the cause of waking, but the want of Impressions will not account for a person's

person's again falling into the Insensibility of Sleep. If a person's waking depended on the fullness of the Nerves, after a long sleep he ought to have his functions in such a state as not to be able to fall asleep till the fluid was in some measure dissipated, but he will fall asleep again merely from want of Impressions - it is incompatible too with the protracting watching, when the Nerves must be supposed to be exhausted by being long kept from sleep.

We come now to the Sedative Sensations & Impressions that cause Sleep.

That single Sensations do not cause it is sufficiently obvious. The Sensations that cause it are reflex, & must therefore arise from the passions of the mind; thus fear & grief are sedative sensations, & diminish the sensibility of the system, but that they do, immediately & produce sleep is not so obvious, for tho' these sensations are at first sedative, yet they cause a reaction of the system, & hence their first consequence sleep is not produced; thus fear if at first it diminishes the mobility of the system, yet if it rouses up the Animal powers it cannot be said to produce Sleep - Grief in the same way whilst it produces anxiety or any desire of exertion will not admitt

of Sleep, but a more moderate exertion a moderate degree of Sadness does, which I have experienced. I have known others too of the same constitution & therefore I reckoned Sedative Sensations among the causes of Sleep, but how they may operate is doubtful.

In this part I had principally in view the Sedative Impressions that are not commonly accompanied with Sensation - that there are many such is well known & of considerable variety, & hence of mixed operation. I shall take an example of the operation of them all from one, viz, Opium.

As it is a valuable remedy it has been the subject of much Speculation & of various hypotheses.

On the supposition of a Nervous fluid depending on secretion it has been supposed that Opium has a power of Inspissating the blood, but there is no evidence of any such Inspissation, and if the Mass of blood suffers any change it becomes on the contrary thinner & more rare. The Turks who use opium in large quantities are remarkable for long retaining the fluidity of their blood - but I will not trust solely to these accounts but observe that notorious drunkards and such Women as have for particular occasions used Opium for a long

long time were remarkably subject to Hemorrhages, and in some of these women I have known the Menstrual flux continue till they were 60 years of age.

The rarefaction of the blood ~~with~~ some have supposed occurs only after a certain length of time — they supposed it by this rarefying power to give a turgescence of the sanguiferous system, and thereby produce compression in the vessels of the Brain, but there is not time enough for this, it is true it recovers afterwards, for if Opium diminishes the energy of the brain it relaxes the Arterial system of course, & gives occasion to the Action of the blood which is in some degree Elastic — again if it diminishes the force of the heart, it makes the larger vessels less full, of course the Lungs do not perform their office so well, & the blood is accumulated in the brain, hence we see that a secondary effect is the rarefaction of the blood, but it does not happen in due time to account for the immediate cause of sleep — but supposing the rarefaction of the blood sh^d be sudden enough, yet after what we have said about compression
(not)

not producing sleep, we can't suppose in the ordinary effects of Sleep from strong liquors &c. that it is sufficiently accounted for by the increased Turgescence of the vessels of the brain.

Again the quantity of Opium that produces Sleep is insufficient to change our Mass of fluids—it is true there are some substances that act in extremely minute quantities, but these are manifestly ferments. There is no other observation that any Medicine or poison unless by fermentation does change the mass of blood, with respect to all other fluids a certain proportion is required—Van Swieten found that a small quantity of Opium introduced into the Stomach of an Animal killed it without any sensible diminution of its weight, and we have likewise other Arguments other Experiments to shew that Opium acts on the Nervous fluid without affecting the blood, whether the Nervous fluid be secreted or previously existing, we have instances of Opium applied to particular parts, & not affecting any more than these parts—I think that Opium does without doubt diminish the irritability & Mobility of the heart after it is entirely separated from the System,
(and)

and therefore after the blood has ceased to have any share in it's operation - this however is doubted by Haller. It is almost demonstrative that Opium does not act upon the Mass of blood, perhaps solely upon the nervous fluid. It does not act like a ligature or any Compression by interrupting the fluid but by destroying it's mobility - we have a thousand instances of it's effects being more considerable when applied to the brain, hence Sleep & waking depend on the different degrees of Mobility in the brain. - Alcohol, Mephitic Air &c act perhaps much in the same manner. With respect to Alcohol tho' there are many Arguments for it's acting in the same manner as Opium, yet many have been of the opinion that it acts by coagulating the blood, and as it suffers considerable expansion by heat it has been supposed to have this effect in our fluids. It is certain that Alcohol has this effect in it's pure state, but we can dilute it so as to have neither the coagulating nor expansive qualities, in which diluted state it is in our bodies.

Evacuations are another cause of Sleep, it is found that all considerable Evacuations if without stimulus & not to such a length as to destroy
vitality

vitality give a tendency to Sleep. This appearance is most speciously accounted for by secretion; on the other hand we have given another explanation equally admissible, viz, that watching depends on a certain Tension of the vessels of the Brain.

Evacuations by diminishing this may cause sleep; thus it is too that we explain relaxation by pediluvium, for this by withdrawing the blood from the head may give sleep, and this is confirmed by another observation that no body can sleep with cold feet. Here the constriction of the vessels in the lower extremities give an increased derivation of blood to the head, and of course an increased tension to the brain - I would farther say that it may be explained by it's acting in the way of Irritation - I own withdrawing the blood from the head in the Pediluvium is by no means a satisfactory explanation - whatever may be the cause of a particular tone in the extremities of the Nerves, this causes a like tone in the origin of these Nerves in the Brain, hence a relaxation of these Nerves in the extremities may cause a relaxation in the Brain, hence it is too that any great heat causes a relaxation and taking off
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from the tone of the Brain causes sleep; another cause might have been mentioned, viz, the taking in of food. This is common to all Animals that after they have taken in meal they generally sleep. With regard to the human species it has been asserted that the Stomach compresses the ascending Aorta and causes an increased impetus of blood to the head. Dr. Haller has saved us much trouble in this respect as it happens also in the brute creation who have it in common with us, & here there is no compression of the Aorta - but if we reject this we shall find another cause - it may operate in consequence of an Irritation the Stomach was exposed to, viz, Hunger, wch Dr. Haller has shown to be a bar to sleep. The removing an irritation tho' not by means which in themselves produce sleep (as opium) have the same effect; thus if a person be troubled with a small stone in his bladder which he voids after having given him some trouble, tho' not kept long watching before, he will immediately fall into a sleep - the gratification of every desire has the same effect. I would not instance Venery because here there is to be added the previous stimulus now removed, as also a particular pleasure wch doth relax the system.

Dr

D.^r Haller in opposing the Compression of the Aorta supposes that there is a much greater quantity of blood in a full Stomach than in an empty one, & so of the other viscera, & that this diminishes the flow of blood to the head, but the filling the Stomach streightens the abdominal viscera. The Stahlians have an easy Theory for this if we were to admitt it by supposing that the Soul is only busy at one place & at one time & hence when intent on the Stomach she neglects the brain. If the influence of the Brain be determined more to one place than another a relaxation may be induced in another part, and therefore favour sleep - any of these you may take at pleasure, none of them are against the general conclusion - the last & most frequent cause I have spoken of before, viz, Muscular Contraction. It is probable it affects these more considerably that have a close connection with the Animal powers - In these that depend on voluntary motion it does take place, and therefore we may suppose the affection takes place in the brain, but I may go too fast in so much as there is no Phenomenon

Phenomenon that has been more favourable to secretion than this. There may be a waste in every contraction of muscular fibres & hence Sleep induced, but you must here take all the difficulties we before proposed on this head. When we have rejected this I am at a loss to say how this takes place, but there is some what in the nature of the nervous power somewhat in the alternate relaxation of the muscles which shows it. Another fact occurs in the Experiments on the irritability of the parts cut out of the body - a heart if it be left without irritation will continue to have it's alternate relaxations for an hour or two, and after it's motion has ceased the actions will again return, but it is as well known that a heart that will continue to palpitate for an hour or two, if you apply a stimulus it will not preserve it's irritability near so long as if left without irritation here as there could be no necessary power it must be by affecting it's mobility, but we cannot say in what this mobility consists.

From the whole then taken together it is probable that there is something in the nature of the
nervous

Nervous power that exposes it to different states of mobility - some of which increase motion in the brain others diminish it.

CIV. By collapse we mean only a less degree of mobility - this conclusion is not started by me but it is what our late Physiologists are running to. See Haller on this subject Prim. lin. P. 585 & 587 towards the end.

We are now come to attempt a conclusion of what we have been saying. - Observe the chain of reasoning that tho' I should not pretend to remove some difficulties attending some of the Phenomena yet I now think it is evident from the most part of the causes that the causes of watching excite & the causes of sleep diminish the motions in the brain. So far we have a proposition not refused, but as the causes exciting motion in the brain do not encrease the matter, nor does it appear that the causes of sleep seem to diminish motion by interrupting the cause of it or of the free communication between the several parts, so we say that at the same time it appears that watching and Sleep are states of Activity & Rest - of activity & inactivity; hence we conclude that

that the Nervous power is capable of action & inaction, of greater & less mobility, & hence I conclude (as in 101) that it is in the brain that these alterations take place; This refers to a great deal of our former considerations. I think the reasoning is connected & probable, that the Nervous power in the Brain is liable to be in two conditions of an active & inert state. Hitherto I have considered it merely as a matter of fact, without considering wherein it may consist or its connection with different Theories. As it is a matter of fact we may for the convenience of language employ two different terms for these, viz, Excitement for the active state & Collapse for the inert, & constantly with the caution inserted in the text, that like other terms such as Attraction Gravitation &c which are only names for facts without conveying any Idea of their particular operation. I here speak of the alternate conditions as conditions of more or less mobility; but formerly with respect to the Inherent power I distinguished between the facility & force of the matter moved.

Facility, I suppose to be the Mobility.
Force, the force of Contractility.

With

With regard to the Animal & nervous power in the Brain, the same distinction between facility & force is necessary - as there is such a distinction in fact. a distinction in terms is certainly proper. Here I shall meet with the greatest difficulties in the nervous system. I shall be puzzled to determine when the one & when the other takes place, & when separate or when combined. In the mean time I employ Excitement & Collapse as the Mobility or force & vigour of action.

As the establishing these facts is of the utmost importance in every system we may employ, I shall shew how far Haller & other Physiologists have entered into this subject. Haller (in 585) says Somnus adeo arduus &c. He abstracts from his Compressio Nervorum because it is always a praternatural Sleep & therefore it resolves into a difference of the quantity & mobility. In the 586 Haller fettered by the notion of a secretion still supposes that Sleep & watching depend on the quantity of matter of the nervous power, but he perceives that this will not explain all the phenomena & hence he makes use of Mobility & Immobility - but he only treats it as I do as a matter of fact; even on the supposition
of

of a secretion Sleep is not merely a state of inactivity from motion but also of Insensibility, it may take place even tho' the Nerves are full, however he says they are capable of Mobility & immobility, & next when he supposes that matter is added he cannot help saying with respect to the Mobility - With respect to the matters added to our blood we are not certain of any but such as increase or affect the mobility. Some may add in quantity, but some diminish the Mobility others may encrease it.

In the next paragraph we see more common causes which he says only affect motion, & these operate too more considerably accidentally. Dr Haller insinuates a cause which is just such as interrupts the cause of motion, a Collapse, which is more than I do. Neither does he give us any reason for this, nor adduces any facts in confirmation of this Theory. If he cannot account for a state of Compression it amounts to an immobility. I think Dr. Haller will be engaged to go all our lengths; if you consider the pains that he has taken to prove ^{that} the Vis Insita has no dependance on the Brain, and that the Nervous power does
only

only encrease it by means of a Stimulus. Now if the Nervous power & inherent power are the same every Argument for the independance of the inherent power will apply for the independance of the Nervous power on the brain, and we shall be tempted to think that Dr. Haller will allow the whole of Sleep to depend on immobility. Gaubius says *qua agente stamina ejus tendi, rigescere, turgere &c.* [Pathol. P. 52A]—With regard to this paragraph the Nervous fibres are to be compared to the Muscular in their activity & that they are exposed to the same action & rest, and that in it's active state there is some change whether you refer it to the Stamina or any thing else; he after this says *vicissimque remitti & flaccescere* &c. this is asserting the two different states of excitement & Collapse. I have no doubt but in spite of his *nec refert* &c. that he has his particular opinions, I can point it out in twenty different parts of his works, but he does not think them sufficiently proved that he can put any confidence in them, & that many difficulties will occur in their application. It is the same with me,

Haynes

Having then endeavoured to explain my opinion I go on to apply this matter in some measure to enquire how far these states of Excitement & Collapse are in different states of the System at the same time.

CV. Now that there are different states of Excitement of the brain at different times, we find from what we ^{suppose} find to be the case in Maniacs & certain Phrenitic patients. — I said before that Excitement consisted in the facility and force of Action. There is an increased force as these Maniacs & Phrenitics are endowed with more force than other Men. — Now when the Stimulus is given the force is as the inherent & animal powers taken together. Hence the strenght of Maniacs must be in proportion to the Animal powers as well as to the excitement of the Brain. For we have no doubt of Mania affecting the brain & hence it's excitement of course. — Here arises the difference between Vigour & Mobility. Mobility may be opposed to Vigour as this disease resists the force of all Impressions, particularly the Sedative ones as cold to an uncommon & inconceivable degree, and particularly that this is a state of excitement because

because it most difficultly admits of collapse. It is opposed to sensibility & mobility in as far that in order to be excited to action it requires stimulus, but when it is produced the action is increased in proportion to the force of stimulus applied. We would wish to enquire how far this is explained by or assists our former explanations. We can observe that it is exactly proportioned to the increased impetus of blood in the brain, this is agreeable to our former opinion that an increased impetus of the blood caused watching.

Probably what I am now going to mention has occurred more frequently than has been observed. Morgagni finds the brain of maniacs remarkably dry & hard in their texture, & an anatomist has found it increased in specific gravity. — Whatever opinion we take with respect to the nervous power it is possibly connected with this that its mobility is in some degree affected.

But to go on to say how the other irritations that produce mania act in this way. The state of the Intellectual faculties is in some degree dependant on the communication. How long continued watch-
ing

ing is a cause of the Excitements going to excess & producing Mania, & why the same arises from Melancholia are so difficultly applied to any Theory that I shall not say any thing of them. Mania is a state of extraordinary excitement.

CVI. Here is a 2^d degree of Excitement lower than the former & higher than the 3^d or state of Sleep, from the former it differs in degree, when we speak of it as differing in this latter respect it is not only in degree but also in extent. Here I speak of it as not confined to particular parts, but as affecting certain functions only. It is that set of functions that are liable to be affected by the alternate states of Sleep & Waking. It is what we call the Animal functions (in opposition to the vital) & are those by which we keep up our connection with external bodies, those of Sensation & Volition; it is in these Animal functions only that the remarkable vicissitudes do take place. It is one of the most difficult problems in physiology & has given occasion to many Theories. Dr Boerhaave considered it as an affection of different parts of the Brain - that the Cerebellum is connected with the vital & natural while the Cerebrum was solely connected with the Animal, but I refer you to Haller to take the Arguments

Arguments against this supposition. He finds that the Nerves of the heart &c. are derived from the Brain. We must then seek for another cause; you may say perhaps it depends on the inequality of the functions of the Brain taken in its larger sense, but the heart has its action depending a certain energy of the brain - but it goes on independant of the Brain suffering any change with respect to its difference of motion &c. It is far otherwise with respect the the Muscles of voluntary Motion, as they are excited with every motion & relaxed on the cessation of every volition; viz the excitement be taken off a relaxation of the Brain ensues.

There is no proposition more firmly established than this that whatever supposition we take with regard to the Nervous System, whether that there is a fluid inherent in the Medullary substance or a fluid secreted in the brain the Phenomena are not to be explained merely by the quantity of matter present or absent, for there is a change also in the quality of the matter so as to be more or less mobile at different times. - Haller
and

and those that make it depend principally upon quantity are obliged to go still farther & mention also immobility. Dr Gaubius is still more pointed but we will not go so far as he does, nor yet with Dr Haller to speak of the Insula Nervea. It is enough for us that it is established as a matter of fact, and having established this especially in sleep and watching I expect to illustrate the matter by condescending in what way these states are found to vary.

As to the several degrees of Excitement first so far as it is implied by a high degree of Vigour & by a less degree of Mobility - & such a case actually occurs in Maniac & Chronic patients, and you will see yourselves how far it depends on those which we have marked as causes of excitement, a 2^d is that which occurs in watching in men in health, and is higher than that which occurs in sleep - from the former this 2^d differs in degree from the latter, it differs also in extent, also by affecting different functions of the Brain in different degrees. The Vital do not meet with the same degree of Interruption

terruption as the Animal - the difference between Sleep & waking consists not so much in the absolute quantity but the proportion - this is a difficult problem in Physiology, to find a matter that will act only partially in the brain - It has been supposed that the Animal & Vital powers depended on different parts of the brain, but this is by no means the case; & Haller and other Physiologists have exploded the opinion entirely. The Cerebrum being concerned in the Animal & the Cerebellum in the Vital functions. - With regard to the Cerebellum having more strict connections with the Vital functions than the brain, there are instances of considerable wounds of the Cerebellum by no means proving fatal. Tho' the functions belonging to the Brain cannot be assigned to particular portions of it, yet the Brain is under different laws with respect to it's different functions.

I have here started a conjecture; it has been frequently a question what influence the Brain has on these functions - it seems that the action of the Heart is more independent of the Brain than the organs of voluntary motion, that the
Heart

Heat depends more purely upon a stimulus exciting the Action of the Inherent power, and tho' this depends on the brain it is yet more constant & not so much depending on continual renewed influx. Hence the brain suffers very little change in the repeated actions of the heart; we can perceive a difference with respect to the Organs of Voluntary Motion - the will here excites a motion in the Brain which is from thence communicated along the Nerves to the Muscles. The one is always there with a motion of the Brain, the other without any considerable one at least - the exercise of Excitement induces Collapse, in this case we easily see why in the one case the Brain is excited, and from hence proceeds a Collapse, whilst in the other case there is hardly any at all. It is principally with these Muscles that are under the Direction of the Animal power that it must be referred to the Brain more strictly, as it is there that these Vicissitudes take place, as the excitement so is the degree of Collapse, and we can see that this may amount to a degree of Sleep. It will apply to
any

any action that does not depend on volition, but to a Stimulus constantly applied & repeated - hence it will apply to respiration as well as to the heart, but to avoid all doubts you know that, with regard to those that depend upon Stimuli it is alledged that they are independent of the Brain only in consequence of being less dependant of the operations of the Brain. It is possible that in proportion as it is less connected with consciousness it goes on with less dependance on the Brain, being entirely carried on by Stimulus & the inherent power, hence whatever has been said of Respiration being a voluntary organ it is probable that by habit it is become independant of these powers at first necessary for its action - hence it will not be liable to those vicissitudes which depend on the alternate states of Sleep & Waking. With regard to its going on without sensation, whenever the will is unusually exercised, we become sensible of a lassitude & it will produce Sleep; thus speaking, which is an exercise of this Organ, of which a moderate exercise produces no fatigue, but in an unusual degree will fatigue and produce Sleep.

These

These actions which are at first uneasy by habit, become easy because they require a less exertion of the brain, of which we have an instance from the same, viz, the Exercise of speaking. If they do not, require an unusual vigour we know that they may be carried on for a whole day without any fatigue at all, hence it depends on an excitement of the brain which in length of time produces a collapse which amounts to sleep, but in these in which the volition is ^{not} concerned it does happen. The heart which I believe is subject to fatigue is prevented from cessation by the stimulus to which it is exposed. It may in different persons & at different times be in different degrees of absolute force, but still the alternate vicissitudes will take place; then it is very evident that this is very different with respect to the Energy of the brain in different functions. This may depend upon the simple Solids, on the Inherent power, on the Tension of particular parts of the system, but it has been clearly shown that the inherent power depends upon the Animal, that is upon a state of the brain which the other considerations point out to be a state of Excitement.

S

I have expressed the different degrees of excitement by vigour & debility, by courage & timidity - these are often Artificial as the sense of infamy may be stronger than the fear of death, but they are in certain degrees natural & constitutional, nothing is more observable than this being given, the Artificial state depends on the natural state. Courage & vigour, debility & timidity are often connected with the different states of this Organ.

I have said further that it is attended with alacrity & sluggishness, but Alacrity cannot be separated from a readiness of motion which I maintain renders the body more prompt in obeying the will at one time than another - this I call Alacrity, the other indolence or sluggishness. This I infer because Alacrity is frequently connected with courage, timidity with Sluggishness. Watching induces Sleep by degrees, and we can observe that the propensity to sleep is exactly distinguished by the Alacrity or Sluggishness of the body. We can observe that the States of Alacrity & Sluggishness are to be considered with respect to one & the same person at different times.

The

The state of vigour must be very different in children & adult persons, yet truly children have more alacrity than adults - here we must observe that alacrity & Sluggishness depend more on mobility than force, this points out the necessity of distinguishing mobility from vigour. The different states of (collapse) are combined with gaiety & sadness, they are however affections of the mind and therefore affections of the Brain - we can in many instances see that they depend on excitement & collapse as distinguished by Vigour & debility, this is in the same person as he is more inclined to sadness. - These states are sometimes dependant on mobility, at other times on alacrity, which commonly implies a certain gaiety as well as readiness of motion.

The old & melancholic are less capable of gaiety & hence less moveable - thus excitement on account of their less sensibility & irritability is nearly connected with that vigour of excitement that occurs in Maniacs, hence there are different states of excitement, & these are a proof of it. I might have marked the propriety to Hope & Despondency

despondency, Hope being connected with Courage & Gaiety, the other with timidity & sadness. These different states of the mind are often dependent on various conditions of the Brain as a corporeal organ.

CVII. I say natural sleep, because I mean to distinguish it from that by Compression which is dependant on an Interruption between the different parts of the Nervous System, & consequently of the motion of the brain. As we said of watching so, must we say of Sleep, that the difference depends on the extent. I have now only to add that tho' in sleep & watching the change appears only to take place in the Animal functions, yet the brain and these functions are so far connected that no considerable change can take place in the one without affecting the other more or less. Sanctorius in his Account of Perspiration says that it is considerably increased during sleep, which if it happens must be principally referred to the heart & Arteries, but I think the fact is by no means established - by all our later observations we find that perspiration is diminished in Sleep, occasional causes being abstracted. Haller supposes either the

the action of the heart or Arteries languish, because every animal in sleep becomes colder. We have no proof that they become more frequent, & from the slowness & weakness of the pulse it is probable they are not so. — Respiration becomes more slow in sleep all unusual stimuli being removed, we know that the Heart & Respiration affect each other.

If the heart suffers no Lapsitude I say this is absolutely inconsistent with the notions of a secreted fluid which suffers waste on every motion, for as it contracts 60 times in a minute you'll perceive that it must a great number of times in a day, & on this supposition it must produce some necessity for a remission, & if you join it to the operation of the other vital functions as respiration, you will see a further necessity for it. — but we have said that these motions do not produce alternate Excitement & Collapse in the Brain. — They do however derive a certain energy from the brain, as we see on tying the Nerves that these motions languish. From what happens in the animal functions we see that a very considerable affection in these must

must affect the others - the same of the vital motions
where the action of the heart is weakened & becomes
less frequent. This is still more considerable in the
Organs of Perspiration. In Sleep all the other secretions
must be diminished w^{ch} depend on the action of the
heart, & also those that depend upon stimuli & their
diminution again is properly referred to the diminuti-
-on of the action of the Brain. The functions of the
Alimentary Canal are likewise diminished in force
in the time of Sleep, but here we must be cautious
as there is danger in the application of general
analogies, for the action in the one part being di-
-minished will make the action in the other be
strengthened & increased, this we may suppose
to be the case with the Stomach. If we may pre-
-sume any thing from final causes, as the taking
of food disposes all animals to sleep especially
Brutes we would presume that the state of Sleep
is by no means unfavourable to the action of the Sto-
-mach. - But whether the advantages (supposing there
be any) gained by this state of Sleep may not depend on
the action of the Stomach &c. being slower than to the
action being increased is doubtful. - A state of Remora
is absolutely necessary for the action of the Stomach,
and

and hence it might be so here, and then the actions of the Stomach are in some degree consistent with the other actions of the Body during sleep. The state of Premora takes place better in those that are subject to want of digestion during sleep than when awake. With regard to most men heavy suppers are less successfully digested, proving a constant irritation to the System & are in many other respects hurtful to it. In many Animals the fever which digestion produces corresponding with the fever always happening in the evening may have greater effects than at dinner when the Reacerbation is either none at all or not so considerable. I will conclude that all the motions of the System depending on the Brain are diminished in time of Sleep. This goes much farther in some functions than in others. There are different degrees likewise in the state of Sleep, we would judge this especially from the excitability. One man will awake with a very slight noise, others will bear very violent ones without being affected. It is also different at different times of the same night. Again that Sleep which follows Labour is much greater than at other times. This has been commonly and constantly observed, but as the extent of Sleep

Sleep with regard to the Animal functions is in
 different degrees. — Sensation and some opera-
 tions in consequence of it may take place when
 it is very far distant from a state of waking, when
 there is a natural waking — but what certain Stimu-
 li will excite & drive away sleep tho' not entirely,
 this is to be referred to the head of dreaming, some have
 referred this to the Mind alone and that whether we
 perceive it, or not it never ceases from thinking. I have
 spoke of this before that it is hardly ever without
 corporeal motions being connected with it. The more
 we attend to examine the various circumstances
 of Sleep the more we shall be convinced that it
 depends on various corporeal causes — [See Dr
 Haller on this subject P. 590. towards the end, &
 more fully in his Elementa] — In so far as we can
 observe the different states of dreaming & not dream-
 ing we may often refer them to the Stomach, & their
 coming on in the morning in proportion as the Sen-
 sibility advances. — In Gaultier's many curious
 circumstances accompanying coma are explained.
 — Pathol. P. 762. — With regard to the different states
 of Sleep & particularly the Somni ambulatio, being
 of more curiosity than use we shall pass over them.
 CVM. Here

CXVIII. Here is what I call Syncope without determining in how high a degree they subsist. I take that case in which they are so far accompanied with want of motion as to occasion a stoppage of all functions both vital & animal. With regard to the natural functions depending upon secretion they must also cease but in so far as it affects sensibility it is certainly diminished. The alimentary canal is less evidently affected, but I presume it as nothing is more common than for disorders of the alimentary canal to concur with Syncope, as vomiting &c. This is a very different kind of Collapse from Sleep as it is different in degree. Physicians having observed the different degrees have endeavoured to mark these by different terms. Sauvage has divided them into genera but how far it may be proper to distinguish them is a question but not proper to be discussed here.

We may consider Syncope & Aspheicia as general with respect to the brain. In the Sauvage is not consistent with his order, for he characterizes it as affecting the Animal functions more than the Vital which we have expressed by the states of Vigour & debility. That species of Sauvage, the Astensia, is to be considered in this way. There are causes that

that act more considerably on one state of the functions than on another. There are cases where the odour of Musk will induce Lipothumia, but the patient is sensible of its coming on without affecting the intellectual faculties. Opium seems to affect the state of the intellectual faculties without so much affecting the heart &c. In the several causes of Fever we have the Confirmation of it, they operate by weakening the Animal functions whilst it seems to increase that of the heart. These are affections of the animal & vital functions, the Natural is also to be distinguished from both. Some substances affect different states of the Stomach, but the effects are seldom quite pure. — the same causes that produce a Lipothumia bring on vomiting very frequently. — this is a large & curious subject. The connection of these several functions are such that whatever affects any one of them considerably affects the whole. — The vital is much connected with the Muscular motion in the Animal, & the intellectual may be dependant on both. To the first there is an objection, in fever which increases the action of the heart while it diminishes the vital powers. — But if in fever we see a great prostration of Animal power we conclude that the vital powers are liable soon to follow & to yield to the same causes. Again

Again, with respect to the others - Opium, ^{which} acts first, on the intellectual faculties will in larger doses destroy also the vital powers.

I proceed now to another Speculation that arises from the same subject - Whilst I have characterized Syncope as a total cessation with respect to all the functions - the lowest degree of excitement is what Sauvage calls Asphyxia, and is to be distinguished from death only in this that it can be recovered.

We suppose a 1st degree of collapse to take place in consequence of Syncope, and Sauvage defines it a state in which the Animal & vital functions languish, & the motion of the Brain is greatly diminished, and this is a greater degree of Collapse than what happens in Sleep because it comprehends both the vital & animal functions; but this view is by no means correct, for Lipothemia is considered as the same affection as Syncope, but they are apparently distinct, as in the latter Sensation & the intellectual faculties subsist - this leads us to perceive that the usual classes into which the functions of the Brain are generally divided, into Animal, vital & natural, these tho' dependant on the brain yet have not their dependence in the same degree -

degree, for the natural seems to be the first affected in diseases of the Brain, then the Animal & lastly the Vital, hence they are frequently not affected by the same cause nor by the same causes in equal degree, that is one cause will diminish the vital powers more than the animal & contra - It is necessary in the study of Pathology that these be attended to & that we collect the different facts relating to it. In the meantime I am so far from attempting any Theory that I don't know any Hypothesis that can be applied to this. - In explaining Memory, Dreaming &c. people have had recourse to local affections of the Brain, but this I can't admit. Another consideration arises from our present subject, viz. Syncope or a case of diminished Excitement in the Brain - and first let me consider it in degree. It is a state in which the whole body is confused, & the vital functions as it were suspended. But, in all the different degrees of Syncope from the first to the lowest degree of excitement or vitality, the body takes the Temperature of the surrounding medium. It proceeds to the Asphesia of Sauvage, which we only distinguish from Death

Death by reviving again by the application of Stimuli which act only on the vital solid. It is probable that the low degree of excitement in the Germs of Animals before we admit them to life is in some respects Analagous to the Asphyxia ^{which} still makes a difference between these & inanimat fibres. In this progress we can often observe that it proceeds in different degrees from the first stage of Syncope till it ends in total collapse, hence death consists in total collapse or want of excitability. With regard to this state of death it may take place in any single fibre or particular portions of it, or in certain nerves while the vital power still remains in others; but we must consider the Animal System as a whole & death when it takes place with respect to the whole system - from a consideration of many of the circumstances of death & Sleep we find that many of the causes act especially on the brain, & the death of any part only proves the death of the whole system - from a consideration of many of the circumstances of death & sleep we find that many of the causes act especially on the brain, & the death of any part only proves the death of the whole system when

when the Collapse is extended to the Brain. This leads us to the causes of death, & which is a problem of most difficult solution & hitherto not sufficiently explained by any Physiologist. - most of them have been contented with accounting for Death when they have accounted for the defect of Circulation, but this appears to me only to produce death in so far as the causes extend to the brain, and that this defect of Circulation is but a secondary cause of Death, the Brain being the primary vital organ in consequence only of an affection of this Death ensues. In what manner the several causes of Death affect us we shd enquire; by practice we have acquired many signs whch we call prognostics, but these are fallacious, nor shall we render them more complete till we find what state of the Brain these express.

The causes of Death may be referred to 2 heads.

1. Those whch act upon the Brain itself.
2. Those whch act on other parts of the system, whether they are after extended to the Brain we shall enquire.

1. Those that act on the Brain itself. These are certain

certain passions of the mind, that certain passions
do kill I believe we have sufficient testimonies,
in proof of - These as passions act directly &
immediately on the brain. I must not here go
back to prove that the Brain is the Organ of
all our passions. In the next place how do
these passions act, or by what means do they affect
our corporeal parts. This I shall not pretend to
determine nor is it necessary to our present
purpose - It is sufficient to take notice of two
passions that kill, viz. the excess of Joy and
excess of Fear. What change these produce in
our corporeal parts I cannot say, but as Fear
is certainly Sedative it may diminish Mobility
& Excitement altogether when in any strong de-
gree. The effects of Joy are at first Stimulant,
hence how it kills is not so evident, but we
proved formerly that Excitement produced Col-
lapse, and hence any excess of the former may
produce total collapse or death, especially as
the degree of Collapse is in proportion to the
degree of Excitement, but it is extremely dif-
ficult to apply the Doctrine of Waste to any
parts of our Intellectual operations. It is diffi-
cult

L.
cult to find how it can be produced by many of our
passions especially those that do not induce violent
convulsions, when it does produce these it will
apply better. There is another case of Passion which
is supposed to kill, viz, a violent grief; this like
fear may go on to a less degree of excitement till
at last it kills. The causes of Fear & Joy have
especially considerable effects, as they are more
sudden & surprising. It will be still more diffi-
cult to apply the doctrine of waste to the sudden
collapse & death induced by the causes of fear.

Another cause of death is Electricity, this is
analogous to lightning & I reduce both to the same
head. It acts especially on the nervous power. When
its action is moderate it acts as a Stimulant, in
higher degrees of force it gives a Stupor, or interrup-
tion of sense with respect to the whole system, but
we have instances of this brought on to a great
degree & still recoverable. It may then act on
the Brain without affecting the organization, as
in this last case they could not recover so perfect-
ly - its operation is more certain as it is direct-
ed nearer to the Brain - When applied to the ex-
tremities it does not kill, but when to the head
it,

it gives this state like the other passions wh
act especially on the Brain - it does it without
affecting the brain in any sensible or evident man-
ner with respect to the Organization - This how-
ever has been disputed & many instances adduc-
ed where there are Lesion of the Brain with ef-
fusions of Blood. But Dr Priestly's latest Expts
shew that the Animal is killed without any external
appearances or Lesion internally. The manner
in wh Lightning produces it's effects may be
yet uncertain, there may be a Lesion internally
of the Organization of the Brain imperceptible to
us, but when we perceive it's effects produced in
any great degree, as in that of Stupor &c without
any destruction of the Organization, we may
doubt of it in the case of Death - A question
here occurs, Does Electricity kill by a poison or
by the Percussion it gives? Both Lightning and
other substances carry with them a subtle poison,
as Sulphur & Mephitic Air, wh fixes the Elastic
fluids of Animals in a remarkable manner,
but by the way it will equally establish the Brain
as a vital Organ whether you take them one way
or

or the other; but I am inclined to take the violence of the stroke, viz, the percussion. There is probably something in this from what we observe in an analogous case, viz, the effects of the Torpedo; we have few instances with respect to their killing men, but they certainly kill other animals. Electricity has been suspected to be here present, but this by the latest Expts has not been found to be the case - it seems to be a very strong vibration, a very strong Mechanical percussion, as in the case of a blow on the head &c. To this must be added the Deaths wch are produced merely by the violence of pain communicated along the brain to the Nerves. As this often produces Syncope we may suppose a very high degree of it to produce Death itself. It is difficult hence to conclude that there is a subtle Organization here destroyed.

A 3^d head of Causes wch operate in the Brain are Poisons. I won't detain you here in ascertaining what they are, as it is well known that there are certain substances wch in very minute quantities produce Death - some by bringing on
Inflamm

Inflammation and Gangrene, others by bringing on Convulsions, others by changing the Fluids.

But Inflammation & Gangrene may be only a higher degree of poison. Convulsion is produced by substances acting on the Animal powers. When the fluids are changed it is still in a higher degree & therefore referable to the same head. Poisons destroy Life by destroying the Excitement in the Brain, many of them act more immediately on the Nervous fluid & the functions of the Brain, & this with no sensible lesion of its substance or Organization. When Mephitic Air introduced into the body by inspiration & instantly kills the person, it has been supposed to act on the Respiratory Organs - but we have instances that it can only act there on the Muscular fibres of Respiration. We have instances on record of its producing an approach to Death or Syncope, & a state of sleep for some years, & the person on recovering his Senses resumed that part of his discourse in which he was interrupted by the application of the Mephitic Air. - With regard to other poisons their effects on the

the functions of the Brain are as sedatives & Narcotics by diminishing the motion & excitement, - for a further account of these vid Dr Mead's last Edition of his Poisons; he had before endeavoured to explain their operation on the Blood, but he is dissatisfied with this and is obliged to own that they act primarily on the Brain & Nervous System.

I gave yesterday some Idea of the causes of Death & adduced a great number of particulars in order to draw such general inferences as the nature of the Facts will admit of. Your attentive observation will evidently shew you that this has all along been my plan. I have avoided Theory & never indulged that favourite pursuit, but when a sufficient Collection of particulars were established from which an induction might be formed.

Dr Gaubius says the *Vis Vitalis* ~~est~~ solidi est qua se ad irritamentum contrahit, that life consists in a certain mobility not only peculiar in the manner in which it is exerted, but in the causes producing it. The same power is in other parts of the Nervous System, as much distin-
guished

quished as in the Contractile solid, and the same causes act upon both. The vita in Solids then consists of & is applicable to the whole of the medullary substance, & consists in being moved by peculiar causes. It is in every part and the brain connects the several parts. The same mobility must take place there then, probably in a peculiar & special manner - this power we call Excitement, this is life, & the absence of it causes Death. We may then expect to find that all the more evident causes of Death do act by destroying the functions of the Brain. - I divided the causes of Death into two heads - 1. Those acting on the nervous system alone - 2. Those acting on other parts indifferently. I began with the passions of the Mind which of all others act most immediately on the Brain. - Next I mentioned Electricity which acts on other parts but then it's action is more peculiar in the Brain, as it is in consequence of it's affecting that Organ that the other parts are at all affected. As to the peculiar mode of Electrical Action we are not thoroughly determined about, strong presumptions are in favour of percussion. - I pointed out other
analogous

analogous causes of Death, the Torpedos acting by percussion, probably causing so great a vibratory motion in the Nervous System as to occasion death by the violence of the Sensation produced. I before have frequently demonstrated that violent Excitement will produce correspondent states of Collapse, the specific instances I need not here mention. I added Poison as another cause of Death, wh how-
ever varied they may be in their operation as acting on other parts of the System, yet certainly act primarily on the Nerves & their origin the brain. We are ignorant of their mode of Operation, we know only in general that they produce violent excitement in the Brain followed by a state of Collapse exactly corresponding terminating in Death.

A 4th Cause is Cold.

As Heat is specially necessary to the Excitement of the Nervous System, & keeping up it's mobility, so cold the opposite state to heat is opposite in it's effects, it destroys the Excitement and mobility we just mentioned; frequent are the instances of Cold destroying the vitality of particular parts with-
out

- out affecting the whole; but this specific affection of Cold must be merely so, to be general & cause a total cessation of vitality, the Brain, the Nervous System must be affected. This I think conclusive from the following particulars. Cold in killing Animals first produces a state of Sleep, that is an affection of the Brain preceding collapse. Here nothing is, more evident than that its operation is directly on the Nervous system, & that it produces this state of Collapse or Death only in consequence of the effects being extended to the Brain & Nervous system.

Another set of causes that perhaps do not act directly in changing the Nervous power, but act by destroying the Organization of the Brain. What is the nature of this organization we are entirely at a loss to discover, but the excitement of the Nervous system is especially connected with it. This is a supposition common with every System I know of, that the Brain has an Organization suited to its several functions, & altho' they consist of a Nervous power inherent in their substance, yet there is a medullary substance of a peculiar organization suited to this, some particular arrangement of the parts of the Brain, by which it is fitted to support the

the connection between the several parts of the nervous system. Whatever considerably affects the Organization may be a cause of Death as in Inflammation, Suppuration, Gangrene & other various degeneracies that occur in the Brain. As we are unacquainted with the Organization of the Brain we can only observe this as a general fact, & may probably be mistaken with respect to some particulars. The force of the blood as some have supposed may destroy the Organization, but this we cannot infer as it is certainly known as a fact, rupture & extravasation not often occurring, unless indeed we suppose it to act like other violent causes of excitement, producing Collapse & Death.

Another cause that we cannot perceive distinctly, acting on the Nervous power, but only that it renders the Brain incapable of communicating impressions from one part to another. This is Compression. If the Muscles become Paralytic, upon the suppression of the Energy commonly communicated to them from the Brain - the energy in the brain arises from objects communicated to it from without, and these being affected, objects not readily conveyed to the mind from without then our machine must be totally passive & stand still, but if
this

this interruption extends to the Nerves which go to the vital organs, it must produce Death - but the force of motions communicated from Impressions becoming weaker Sleep is produced, and as a chief means of the Excitement in the Brain is the force communicated from Impressions; it may merely from want of Impressions fall into absolute Collapse, Compression produces it in different ways, it may be by taking off the Excitement & by preventing the propagation of that motion which is necessary for the vital functions. If the Compression we speak of were extended over the whole Origin of the Nerves it would be conclusive, but the Compression is often only a partial one. If you look into Astruc, Book 3^d P. 177. you will see that a Vertigo depended on an Inflammation on the Pineal Glands he has another instance of it's being swelled to the size of an Egg which at first produced blindness and then Death. - A Coma likewise depending on no other affection than an abscess of the Cerebellum, and that no larger than a hazel nut &c. &c. -

I believe these do not act by Compression alone, but somehow by affecting the Excitement in other parts of the Brain. This consideration will show that

that amongst the causes that act by destroying the texture there are many of them that act more probably by destroying coæstiment. This finishes the set of causes that act more immediately on the Brain & Nervous System. I go on to mention those causes acting on other parts, but produce Collapse & Death in consequence of this ultimately operating on the Brain. These may be divided into two heads—1. Those that generate poisons—2. Those that diminish the Circulation of the blood—To the first belong Gangrene & Sphacelus, which often shew their effects first on a small part of the body, but very soon prove fatal—Their manner of operating may be variously explained, a putrid matter being generated, in consequence of Stagnation it may prove an active ferment, & by diffusing itself over the fluids may interrupt their course— but perhaps they are only in such consequence as to affect the Nervous System, as in the other cases of poison, the effects are discovered in the Brain, observe how soon it brings on Delirium Asthenia the forerunner of Death.— Not only the more evident causes of Gangrene & Sphacelus lead to this, but to this belongs also Suppuration, which
term

term I use for any matter collected in particular parts that are not strictly laudable pus, & other degeneracies of the fluids in consequence of Stagnation, but they may be converted into active poisons & affect the Nervous System causing Death, as for instance Scurvy. This disease originally begins from a degeneracy of the fluids which are much altered in quality. With this change there is always accompanied a prostration of strength, a languor virium & a remarkable debility that can only be accounted for by it's affecting the Nervous System & proves fatal without destroying the texture or affecting the Organization of the Brain. Hence all the poisons produced by the causes we affect stagnation &c act only on the Nervous System & kill by being communicated to the Brain.

Those that interrupt the circulation of the Blood; any Interruption in the circulation of the Blood will produce Death, but it will be a question whether they occasion death necessarily, but only as circulation is necessary to the functions of the Brain.

1. A quantity of fluid is necessary & this being liable to waste it will be deficient in quantity unless

unless it be supplied by Aliment taken in and properly assimilated, therefore the causes of Death may be owing either from a want of Assimilation, from an affection of the passages preventing the conveyance of the food into the Blood, by large wounds of the Stomach & Intestines, or by crusts formed on these from the Mesenteric Glands &c becoming Schirrous, & from obstructions in the Lacteals & Thoracic Duct - it may either proceed from a defect of Assimilation, from a cause very obviously sufficient to produce it, a defect of Aliment - but tho' I have stated matters in this way yet I think they seldom induce Death by a mere want of fluids. The fluids from a want of Aliment become Acid & Putrid, & thus may act on the Brain as a poison.

a 2^d Cause is Hemorrhages or any such great evacuations.

a 3^d set are those which supposing the fluids &c in due quantity & confined in their proper vessels are yet interrupted by these in their course thro' the heart & arteries, such as Polypi in the larger vessels, & ^{to} this belong therefore the diseases in the Organs of Respiration which by preventing the course of the Blood causes death. - Suppose the
Blood

Blood to be in due quantity but its course not continued on account of the Palcy of the Heart.

In enumerating the case of Mortal Wounds the first are those that prevent the Influa of the Nervous fluid from the Brain to the Heart. Boerhaave is of opinion that these are mortal, and he subdivides them, first, into those, 1st, of the Cerebellum, these may affect it's true great part of the Nerves going to the heart, but these don't infer a Palcy of the Heart in many cases, neither do they prove so often mortal as he would insinuate, & wounds of the Medulla Spinalis don't immediately destroy the Nerves of the heart but act in another manner & hence it may not be so often a hinderance of the nervous Influa into the heart. Dr. Haller has given us this fact in his Treatise on Irritability & Sensibility, that he could not frequently prosecute his experiments, because that the tying of any large Nerve as the Sciatic prevented the Circulation & such circumstances were produced as ended in Death - in wounds of the Cerebellum we may suppose Suppuration with a peculiar degeneracy of the fluids which like other poisons may produce a degeneracy of the Nervous fluid itself, & destroy the

the Excitement of the Brain the Origin of that system. Amongst the several causes that act in affecting the circulation are such as interrupt the motion of the blood to the Brain. The Carotid Arteries may be tied without death ensuing, but this is owing to the blood circulating to the Brain by means of lateral communications & tying up the vessels - but tying up the vessels for a certain time will occasion death. All these causes of Death are shorter than the causes affecting the fluids merely from want of nutritious fluids. - a degree of Tension & fullness in the vessels are the means of keeping up the due degree of Excitement. If in a Fever the functions of the heart go on well, & the vessels of the brain have their proper share of fluids the excitement is pretty well kept up, but the least Elevation of the body brings on a gravitation from the brain & empties it's vessels, the consequence of this is an immediate relaxation & loss of tension, a Collapse & Deliquium ensues, and nothing is to me more conclusive than that a certain degree of Tension is necessary to the functions of the Brain, to its due

due degree of Excitement, but still with regard to
all these that interrupt the circulation it may be
a question whether the Brain or the heart are
the primary functions - if the Brain is proved
to be dependant on the heart, then our Theory of
the Nervous system must fall to the ground -
but if the Heart depends on the Brain then
Death cannot ensue, but by interrupting the
functions of the Brain. - So far as we can see
the rationale of the Action of the heart we find
the Action of the Nerves & Brain in the first for-
mation of Animals precede the *punctum saliens*
or first commencement of the motion of the Heart.
Again, Life subsists after the Action of the Heart
has entirely ceased, of which we have instances
in the various Amphibia; there is, it is true,
a difference between these & the warmer Animals
with respect to the dependence of the Brain on
the heart, but this at least shews that the power
of the Heart may be withdrawn and life subsist.
I could produce many Arguments for the Brain
being the primary Function on which all others
depend, and therefore the Brain may be said
to be the *primum vivens*, and *ultimum*
moriens.

Vitality

Vitality as extended to the whole System depends on the Excitement in the Brain, & the Soul only quits the Body when its immediate organ the Brain is destroyed—These considerations lead to the last conclusions I have formed, & it is only from an attention to these that the causes of death can be explained.—Some of the causes may not, be so evident, fevers are diseases & causes of death, but how fever occasions death has been long & is still a difficult problem. I cannot enter fully into the subject without condescending upon the nature of Fever, this only I would say that it enduces Death in consequence of its action on the Brain. Boerhaave has touched on this in one of his Aphorisms, in which you'll see he proposes considering the head of causes interrupting the circulation.

Having now finished nearly the subject, let us consider the whole we have said in one view, in order to accomplish this I shall make a short recapitulation.

The Brain must be considered as forming the Communication between the several parts of the
Nervous

Nervous System & uniting them together. The Nerves are appendages to this, & serve only the purposes of extending the communication to the remote parts of the System, having no powers of their own but what are derived from this Organ, in consequence of whose peculiar structure & organization certain motions energy are excited by which vitality subsists in the System, & all the functions & parts that constitute the human machine. The union of the several parts & extent of Communication are proved from the Motions, Contractions &c. excited in distant parts in consequence of Volition & other motions first begun in the Brain. The Brain modifies these Communications according to its different states & conditions, & Impressions have different effects in producing contractions according to the varieties of the condition in the Organ. These modifications of the Brain are generally connected with the intellectual operations, and much may be attributed to the sentient principle. But the Brain is to the effect of Modifying Impressions an Organ purely corporeal, & these Modifications go on without

without any evident interposition of the intellectual faculties. But as it is the opinion of the most considerable Physiologists & in itself highly probable that even when the Brain exercises its faculties it is a corporeal substance where changes are going on correspondent to the intellectual changes. The Brain then is an Organ of a peculiar structure with ~~wh~~ we are entirely ~~entirely~~ unacquainted & whose operations must necessarily be observed, as they are less obvious & nothing is more remarkable than that the operations exercised in the Brain are liable to the vicissitudes of rest & activity, to the alternate states of Sleep & watching. This is somewhat that affects its general, & if we discover any of the causes of these noted vicissitudes, we shall discover something of the general functions & conditions of the Brain. I began therefore with this subject & examined the Doctrine of a secretion performed in the Brain. I found the Doctrine of a secretion to be well founded in general, but the particular application of it is arronious, as
this

this notion of a secreted fluid serves for other purposes than sense & motion, & is incompatible with all the Phenomena of Sleep & Watching. The other opinion I likewise rejected, & think that these vicissitudes do not depend on powers that act merely by interrupting the communication of motion from one part to another, & no Phenomena occur that account for the operations of motion, without a change in the matter moved.

These two positions being rejected we are led to a third in my opinion much more probable - that these vicissitudes depend on the nature of the matter moved, i.e., the nervous power, which may at different times be in different conditions of greater or less mobility. The principal causes of watching are such as excite motion & mobility in the brain, Sleep on the contrary by diminishing these motions. This is a very probable account of the Phenomena of Sleep & watching, & of several others of the Nervous system. Here I conclude not only as my own opinion but also as the opinion of Haller & Gaubius that whatever may be said with regard to the quality of the matter there is a state of mobility.

bility that alternately takes place in the nervous power, & it is these two states I have given the names of Excitement & Collapse. These are not intended as names to support any opinion or to imply any particular mode of action but merely for terms as facts. I thought it necessary to shew that these states of Excitement were in different degrees in different states of the system, some of the most noted differences with respect to Excitement I have endeavoured to mark out, as first in Maniacs watching, & in Syncope Sleep. With regard to them all they may be considered as different in kind, & may require different considerations as affecting different parts of the system. In Syncope we can observe that whilst we can trace the excitement becoming lower & lower till at last it ends in death, whence we conclude that life & death of the Animal System are distinguished by the state of Excitement in the Nervous system - These Speculations necessarily lead us to consider the causes of Death, & it appears that the greatest part of them act on the Nervous system of Animals & diminish the Mobility in the brain. Some of the causes of Death tho' they act upon other parts of the system yet many of these

these, as poisons generated, act most properly on the nervous system & produce death merely in consequence of affecting the Brain. Such causes as induce a Paralysis of the Heart & hinder the Access of blood to the Brain effect this by a primary action on the brain, the heart depending on this for its constant subsistence, & therefore upon the whole our Doctrine is pretty well confirmed. I observed, that the causes of Death are variously united & complicated & we may be exposed to say how many or how few of these causes have operated in Death, this leads us to apply our considerations to many diseases. I thought proper to apply it to a principal one, viz, Fever. We are so often interested in finding out the cause of Death here that it has been considered as an important problem, it is difficult & is still unexplained. I can only here give you a few general remarks sufficient to confirm our present system, that Fever acts chiefly on the Brain, but before I do this I think proper to take notice of the different systems that have been started on this subject.

1.st Boerhaave's as it is laid down in his 592 Aphor. in which he first gives his system on this subject before

before he expresses the different terminations of fever; he refers the several causes of Death in Fevers to 3 heads.

1. The force of Circulation destroying the Texture of the vessels.

2. A change of the fluids so as to become viscid & interrupt the flow of the blood in the vessels.

3. Obstructions of the passages of the Chyle.

As to the first I could shew it not to be correct, it rarely takes place but allowing that it does it has no influence on our present System. Van Swieten adds that it may kill by effusions & other parts besides the brain, but this is owing more to a dissolved state of the blood, rather to a putrid dissolution than to any increased impetus.

The 2^d is founded on the doctrine of Lector which I take to be entirely Hypothetical. Physicians are now aware that however you may erroneously argue about causes that the blood becomes dissolved by putrefaction in fevers ten times for one that it acquires a Lector or Vicidity. If the fluids are wasted & the aqueous parts fly off still the remainder (as opposite from acquiring a Lector) will remain thinner, but I must not enter into the Animal Economy in this subject.

subject as it would be too far from the point. Van Swieten talks of Lensor affecting the vessels of the Cerebellum and farther supposes that Lensor may operate in the vessels of the Lungs, but the manner in which Peripneumony kills is by effusions of the Blood.

With regard to the 3^d head, his Ulcera Aphthosa occurring in the Prima via, this may be a cause but I believe will be found to be a very rare one & upon the whole this account is very incompatible & goes but a little way to account for the causes of Death. It proceeds upon a supposition that the causes of Death only take place in the hot fit of fever, but neither is this the cause of Death, nor in this does the fever consist. The subtle poison in the plague that acts on the Nervous System & it's first action on the Brain appears in a cold fit. Van Swieten says that this is an effect of a greater degree of Impetus produced, & the cold fit is certainly the effect of a disorder in the brain, & the cold fit is the most material part of the disorder in which a cessation of Vitality most frequently happens. Fever is a cause of Death operating on the Nervous System

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tem and destroying its Excitement, and by the Sympts that accompanies it, it acts by a gradual diminution & at length a total destruction of Excitement.

From the whole therefore it appears that Fever operates only on the brain, and there produces a total extinction of Vitality. Fever is often a putrid Ferment accompanied with all the marks of a putrid decomposition which acts rather on the Brain than on the fluids by rendering them unfit for circulation, it does indeed act on the fluids & renders them unfit for secretion & produces a degree of Liquidity that may induce Death & occasion compression in the Brain wch is very frequently an operation of Fevers. These effusions of Fever are thrown into particular parts and produce in consequence of stagnation a ferment & occasioning a Gangrene in the parts produces Death. Thus I have shewn that the chief operation of Fever is an affection of the Brain, & have enumerated many particular causes of Death from fever all which are omitted in the Boerhaavian System, and thus it appears that Fevers analogous to other causes of Death act by a diminution of Excitement. I am to speak of one other cause of Death, as it is perhaps an important one but of very difficult

difficult investigation - it is the *Mors senilis*.

Different explanations have been attempted on this subject, & some have refused it altogether as a separate cause, and allege that old people always die of disease, but it is a disease that the circumstances of old age give particular occasion to. There is a state in the Animal Economy that without any fault in the Organization renders it unable to execute its functions in the same vigour as before. This decline in the vigour and perfections goes on till they become altogether unable to execute those necessary for life & this gradual declension is what is called the *Mors senilis*. It is evident that a change is going on in every part of our System, in the simple solid, in the state of circulation, & in their peculiar Organs - less evidently but as certainly in our fluids, & in the circulation & its peculiar Organs as well as in the more vital powers. These changes are such as render them unfit for their several functions. But the great omission is not to have observed that all these changes act by affecting the Cerebral functions, & however obscure the manner, very probably there are circumstances in its own nature on which these depend - hence
it

it is wrong for all Physiologists to account for the more senilis affecting the circulatory functions only. Haller leans much to this opinion & this is only a description of this more senilis without tracing it up to its proper causes. He imputes it to the loss of the *vis insita*, to the want of the peculiar irritability of the heart; but the question is whether the heart ceases from a want of Irritation in its proper fibres or from a want of the proper stimulus. In 972 Haller resolves the whole into a debility, its source however is plainly a failure in the Action of the Brain, the decline of life is ushered in by the decline of the Animal functions which is constantly increasing in those & extending to the other functions. There is some inequality in this failure, in some the Mind in others the body fails first, but it is first in the functions of the Brain becoming weak & excitement diminished, so that it is no longer excited by the ordinary impressions of the System, & the usual moving powers. It has been supposed by Philosophers that inanimate matter may by the powers of fermentation be brought to a state of Animation, and if so we can conceive its gradual decline to inanimity analogous to other Animals. But I must confess the notion
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of rendering inanimated matter to an animated state is suspicious, and I think that life & Animation are totally separate substances or existences from the matter they adhere to: they remain till the Corporeal part declines, and then vitality deserts them.

As the Nervous power in the Brain is liable to different degrees of Mobility wh we call the different states of Excitement & Collapse, so there is a probability that the same takes place in the other parts of the Nervous System. There is no supposition on this subject that allows that the Nervous power moves faster and slower at different times, wh we suppose to depend on the mobility of the matter. Those that do not must have recourse to other means supplying this faster and slower motion they must say that the vessels that contain it are liable to a quicker motion at one time than another, but these vessels are composed of muscular fibres wh must be subject to Stimuli applied to the living solid, so that the question recurs upon them.

I go on to say that after finding that such states as Excitement & Collapse do take place we find that Sleep depends on a state of Collapse. We consider Excitement & Collapse as taking place with regard

regard to the whole System, and as it stands in the following proposition.

CIX. But the truth is that after having been obliged to explain this again, this Paragraph is in many respects incomplete, the latter part requires our more particular attention.

Excitement & Collapse are to be considered in many other respects than sleep & watching, and in mentioning the causes of Sleep & watching, I have assigned the chief causes of Excitement & Collapse in other respects. But we shall now consider the whole causes of Excitement & Collapse in other parts of the System. We must consider such of these as affect one set of Functions more than another as giving vigour or debility, mobility or Torpor &c.

Every action excited by the Brain I call a State of Excitement, I think every Stimulus is a cause of Excitement not distinguishing just now between Stimulants & Tonics but as they contribute to the Vigour & Mobility of the System.

From all these distinctions I go on to mention the different causes of Excitement & Collapse with regard to the whole of the System. The states must depend on certain conditions of the medullary substance

stances; this arises especially from our saying that we must suppose some such difference in the original stamina of Animal bodies. Every organized body is from Stamina at their first erection. Afterwards by their Organization a characteristic is given both with respect to vigour & mobility during the whole of life we must trace up the cause to the original germs; but it not only depends upon it as thus derived from the original Stamina, but the states of Excitement are varying thro' the whole of life - we observe it in a great measure following the state of the simple solid. I in a great measure despair of any explanation of this, but we must consider the changes of the System also by considering those that follow. -

a 2^d Cause is Heat - When other circumstances concurr nothing is more powerful for bringing Germs to life, both Animal & Vegetable, and we observe that life requires a constant excitement of which Heat is the support. On taking it away it returns to inanimate matter. This heat is produced in two ways - 1. The body has a power of generating & supporting heat in itself, more or less dependant on the external heat - & 2. both these taken together.

We are now to consider the effects of the last, viz, Internal Heat. This is universally to stimulate excite, there is a certain temperature consistent with our generating power that preserves the Heat necessary for our Economy - but it is in the middle temperature that it is a stimulating power, but beyond a certain degree its effects on the System in this respect are considerably diminished, as it produces changes wch diminish the generating power - here in speaking of the effects of heat we can go no further, for here it is that we might have occasion to distinguish its effects as giving more or less vigour or mobility, which we would not at present touch upon.

A 3^d cause is the Action of the Heart, possibly that particular action which determines the blood to the Brain in certain quantity and time. There is a certain fullness in the Vessels of the Brain that in all Animals is necessary for the support of life. In some more constant and less dependant on the heart & the excitement does not immediately sink upon its being withdrawn. We can observe too that too great quantity is capable of exciting to excess, and I cannot help observing that when after

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a state of Collapse has taken place a greater degree of excitability takes place, we have occasion to impute it to this cause, viz., a constant impulse to the vessels of the Brain, tho' a certain degree of this may produce the contrary.

4.th Stimuli arising from the exercise of the other vital functions, I have said that the action of the heart & lungs go on without any considerable interposition of the Brain - on any unusual exercise they become a stimulus, so the action of the Stomach does not naturally give a stimulus yet if proternaturally excited it becomes a stimulus, and if the Nerves of the Brain are supplied by impressions with or without sensation we cannot surely doubt that they are so in the vital & natural functions, and that upon withdrawing them as they are contrary effects this will be still more evident. Weakness of respiration & the absence of the action of the Stomach & intestines, & when so small a matter thrown in will prove a stimulus & thereby take off the disagreeable sensation produced; these I say are sufficient instances of this.

A 5.th cause of excitement is the several means
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of Tension and Tone in the several extremities of the Nerves. Nothing is more certain than that there is a mutual pressure or action of the parts of the nervous system upon each other. We have before explained how the sentient extremities can be under different degrees of Tension - the taking off of these is a considerable means of inducing collapse, hence in so far as these Tonics can act on the extremities they must have a share in affecting the Origin.

We now proceed to those that are more evidently occasional.

6.th All or most sensations of Impression considered as simple & direct sensation. We have no other Idea of Impression but as a motion communicated from an external body in motion to the extremities of our Nerves. In the Eye, Ear, Touch &c we can perceive the Mechanical effect an increase of motion &c. & so far the Impressions we call sensations are Stimulants. We cannot determine but what the diminution of motion may give sensation. - Some Impressions may be of such a nature as may destroy the mobility of the Nervous power.

7. Amongst the causes of Excitement are the
several

several Sensations of Consciousness as enumerated in XXII. that however the mind be engaged in Sensation it is a state of Stimulus & a bar to collapse - another is the State of Volition, some of these may be doubted whether they are active with respect to the System, as from volition, in particular or general. Those that arise from vigour are certainly stimulating, those that arise from debility have a contrary effect.

8. Many Impressions without Sensation but analogous to those producing Sensation. Of these are the various Articles of the Materia Medica. If applied to the Tongue they give a Sensation, but if applied to the Stomach they act upon the whole Secretory & Vascular System without giving Sensation, but I refer you to the materia medica for the particulars &c.

I suppose Stimuli not only analogous to sensations of Impression, but many changes of the System analogous to these producing Sensations of Consciousness may be Stimulant also. Of these are powers that must act on the Nervous System without producing Sensations of Consciousness. I mentioned these under N. N. When the Stomach &c. have an unusual dose of Stimulant or Sedative Medicine they give Sensations of Consciousness, and motions are communicated

-cated to the Origin of the Nerves as I said just now. It is not to be confined to the Heart & Lungs wh are more obvious, but the Musculi vasorum Arteriarum may have effects on the small Nerves wh may be analogous to Sensation

9. Reflex sensations of pleasure & pain from whatever Impressions - as I have distinguished these from the agreeable & disagreeable pleasant & uneasy &c, some of these are Stimulant & others of them are Sedative. This cause is with two conditions, 1st the pleasure & pain whilst actually operating, & 2^d it is both when only operating in a moderate degree. Excess of Joy & bodily pleasure, & pain are to be referred to such violent Excitement as end in Collapse & Death.

10. Motions or Passions that are agreeable & active at the same time. Joy & Hope are emotions that are Stimulants as they are delightful, Love, pleasure, anger or hatred as being active motions are powerful Stimulants to the System.

11. Emotions & Passions tho' in their simple direct action are uneasy & disagreeable, yet if they lead to action may excite; Fear for instance tho' certainly a Sedative Impression, yet when it produces a certain

certain degree of Collapse it is no inconsiderable Excitement, and when the Sedatives in general act in this way they prove strong causes of Excitement. Some causes however of Collapse are so strong as to induce Sleep in spite of any Stimulus, but this comes under another head.

12. Certain Impressions that are Sedative, but from certain circumstances are at the same time Stimulants, or if you will that this is only by an indirect & secondary operation, a certain condition of the system by which it is disposed to a resistance of those substances that have a power of destroying the system. Hence Sedatives prove Stimulants on one of these foundations. Many of them are besides causes of sensation whence they often act as a Stimulus. The absolute force of Cold destroys the mobility of the Nervous power, but as a certain force of Impression is connected with it, it proves Stimulant.

13. Certain conditions of Sensation that have a tendency to render some of the exciting powers much more powerfull. I have my notion from what happens in Dreaming & in Maniacal persons. As we observe that every Man in going to Sleep & coming out of Sleep is in some degree affected with

with delirium, hence I think, delirium seems to depend on an unequal state of excitement in the Brain attended with &c. I have this not only from Analogy but from Dissections. Most states of Vesania depend on partial Compressions of the brain, and in all the cases of Interruption they are attended with an excess of excitement.

Dreaming & Delirium tho' they act more strictly on Memory, yet they are not Ideas but Imaginations that are renewed with a persuasion of the presence of the Object. But when we consider how slight the causes of Dreaming are, as slight uneasiness of the stomach or of posture, slight noises &c, we shall see that there are some circumstances in the Brain that render these slight Impressions stronger than they naturally are. There is something in the causes of Dreaming & Delirium, some circumstances in the brain that create a strong degree of excitement, I w.^d say that they arise from an irregular unequal excitement, but this is only probable, as from the obscurity the subject is involved in it can by no means admit of a Demonstration.

Sleep is a cause of excitement, for tho' Sleep induces waking, it induces also a return of excitability, and I

I would add this further that it does not only induce a degree of excitability but new force & vigour in the Brain - from these Stimuli that are sufficient to produce a degree of watching we find the vigour of the system greater than at first falling asleep, I leave you to adopt any Theory you think proper on this subject. I now go on to mark those that have a contrary effect.

1. Certain conditions of the Nervous System unfavourable to or improper for motion & excitement.

2. Power of Cold.

3. The weaker action of the Heart with respect to the whole System, especially the Brain, & the other conditions affecting the functions of the System, & hence Evacuations are to be taken in.

A. The weaker action of the Animal & vital motions must diminish the Activity of the Brain, & hence when poisons are taken into the ^{Stomach} ~~subject~~ we can observe as they act there by producing sedative effects that it is proportionally over the whole System - a constant Stimulus arises from the Exercise of the Vital & Animal functions.

5. The Diminution of Tone in the several Extremities of the Nerves - If a warm bath relaxes the Cuticle

Cuticle & sentient extremities this is communicated to the Brain; & hence it's power in debilitating & weakening, there is little doubt but all similar causes have similar effects, as the pressure of the atmosphere being taken off &c.

6. As Impressions producing Sensations are generally Stimulant & there is hardly any time in our waking hours but we are exposed to them, any deficiency of these accustomed Impressions may cause Sleep.

7. Certain Sensations of Consciousness as mentioned (under 1. & 6.) which arise from debility & weakness under the Article of Impression as agreeable & disagreeable universally weaken the power of the System.

8. Sensations that engage attention & prevent our own thoughts or lead to no relaxation or exercise of thinking. All Attention that does not exercise our own thinking faculties tend to diminish the motions otherwise subsisting it - as the same Tone without Melody or variation allows all these motions to subside or cease.

9. Impressions without Sensation, but known by Experience to have a sedative tendency - their operation

operation is various, certain occasions being sometimes necessary to concur for the action of these sedative powers.

10. All reflex sensations disagreeable & uneasy comprehending all the modifications of it not leading to action.

11. Pleasure & Pain to a certain extent.

12. All emotions & passions that are disagreeable & uneasy & do not lead to action.

13. Exercises of the Mind & Body in a certain excess of force & duration. I abstract from all others. It is a fact that the Exercises of the Mind & Body in a certain degree of force & duration induce Collapse.

14. Certain conditions of the Brain. As there are certain conditions of the Brain that give occasion to a stronger excitement, so we may suppose that there is an opposite to this, but there is here to be mentd as a cause the various & well known cases of Compression which is a means of interrupting motion in a matter well enough fitted in other respects. In Application we wd imagine that a very extensive Compression is necessary, but there are instances of a very strong Compression producing Apoplexy & Death, hence I imagine this affects also the complex

complex Organization.

CX. Having thus endeavoured to assign the diff: causes of Excitement in the brain with respect to the whole we come now to those that may take place in other parts of the Nervous System. In the Nerves thus strictly limited we do not know that the Nervous power suffers any change that is not exactly analogous to that in the brain. If Impressions arise whether in the origin or extremities that are sufficient to propagate motion these will, take place along the course of the Nerves; this however is not strictly accurate. Any portion of the Nervous Substance is capable of a separate affection. There are 2 Reports in confirmation of this. On cutting thro a Nerve belonging to a particular Muscle he by irritating it produced a contraction in the Muscle, but after repeated trials it no longer produced the usual effect. But when he had cut off that part of the Nerve that was thus bruised by the former Experiment, the portion of fresh Nerve between the Muscle & him exhibited the same effects as before. A similar effect occurred in Dr Smith's Experiments, when he made use of common salt at first it produced contraction in a Muscle but after a trial or two it no longer had this effect till upon applying it to a fresh part of the same Nerve it acted as before. This looks as if several portions of the Nervous System to a great degree of minuteness can be thus separately affected. With respect to the Nerve we need not look for any other cause but that of Interruption between the Origin & Extremities.

CXI. I would now point out the causes of the different circumstances in the Sensitive Extremities (XXXIX 2, 3, 4, 5.) which may be varied by the different states of the integuments containing them, the difference of Nerves as they occur in Age, Sex or Temperament, whether depending on original Stamina or what I shall not here determine. In the Eye and Ear the Sensitive extremities are very little exposed to any thing that can change the medullary solid, but in Taste, Smell or Touch they evidently are. We discern more distinctly that circumstances peculiar to the medullary substances are varied by blood vessels intermixed. There is one case of Insensibility that is owing to an excess of Tension. Whilst there are a number of blood vessels intermixed with the extremities of the Nerves they may act by compression. In the Choryza where the smelling is lost we would impute it to this last cause.

The change of Sensibility is connected with Heat and Cold in the extremities of the nerves.

From the whole therefore of these causes it is to me obvious what answer we may give to the Query subjoined. I proceed now to consider with respect to the moving extremities, which may be also in different conditions with respect to the nervous power.

after

After considering the states of Excitement in the Brain and its various causes, I examined how far States analogous to these may take place in other parts of the System. It is possible that the state of the Nervous power may be changed in Nerves enveloped by Membranes, however they are little exposed to such causes as they are not in themselves Organs of Motion. The changes in these will indeed intercept the communication of motions between the origin and extremity. With regard to the sentient extremities these are under different degrees of Mobility, and if we attend to this that different states of Tension & heat will give different degrees of Mobility and Sensibility, we shall perceive that they are in states analogous to excitement & collapse.

CXII. With respect to the Motory extremities we find them more liable to different states and conditions, and suppose them to be affected by the Inherent power independant of the Brain, how far this arises from circumstances of peculiar organization is uncertain. The Muscles says the Physiologists are in peculiar circumstances in particular parts of the System. In the Heart, Diaphragm, Stomach &c.
Haller

Haller from thence concludes in these a difference of Organization, but this opinion we endeavoured to render doubtful, for muscular fibres as far as we know are the same in all animals have the same Organization and particular muscles have their inherent power strengthened from other circumstances. The question is whether the common Organization is liable to be changed, and thus give a difference of condition to the functions of the fibre, we know not how it may be changed or if it is liable to any change - considered as a simple solid in this view possibly it has some influence on the functions of the muscular fibre like the simple solid to change in the progress of life. As a Muscular Fibre consists of a peculiar mixture it may be affected by various causes affecting the mixture, by corrosive and other powers analogous to these we can perceive that the moving fibres are surrounded by numerous blood vessels, and according to the different states of these the states, either are simple or organized solid may depend - but this is extraneous to the subject and does not at all affect our present question. - Its condition may be varied by causes affecting its tonic power. The Inherent power is perhaps connected with the state.

state of Tension, as the extension of the Muscular fibres proves a stimulus to their contraction the inherent power in muscles will be *ceteris paribus* as their degree of Tension - This I before discussed in Prop. 83. - What we maintain is that the inherent power in some respects depends on the Animal power. The state of Muscular fibres separately from other considerations can be much increased by habit and repetition. The facts are sufficiently known that any Muscle being frequently exercised acquires more force in proportion to the rest of the System - This may partly depend on the brain, but these may also more easily be affected by certain causes than others exclusive of the power of the will - By their connection with topical Stimuli, and this will have effect when they are totally separated from the Brain, and in living Animals Stimuli act on particular Muscles without producing any change in the Brain, or at least any considerable change, these however must operate on the inherent power - probably the more durable nature of the inherent power, in the heart, depends on its being a muscle irritable by a particular Stimulus and not dependant on the power of the Will. Since so many of the moving fibres can
be

6.
be affected by particular causes I should have added that muscles on many occasions are likewise exposed to the action of sedative powers to certain narcotics to the power of cold, and there are causes sufficient to act particularly on the moving extremities and give to each a different state of the Inherent power. I have said that certain portions of muscles are more liable to be acted on by particular and general causes than others. When we consider how often it depends on particular causes of Tension we may suspect something analogous to tension in the sentient extremities and similar to the states of excitement in the Brain itself - and tho' I hint this in the shape of Queries yet I venture to answer it in the Affirmative, that the different extremities of the Nerves are liable to states analogous to those of Excitement and Collapse in the brain, and its influence will be different according to the states of the Extremities separately considered, and when they communicate motions their effect on the brain will be as the state of the extremities. These considerations do much influence the mutual ~~action~~ action of the Origin and extremities on each other. I have just now endeavoured to shew that every moving fibre may have

have its excitement more or less affected by the rest of the System - and certain portions of moving fibres are liable to be affected by causes acting directly upon them, or produce actions greater than those that are operated on by general causes. These I have particularly condescended on and are

I. In the Organs of Voluntary Motion.

II. In the Sanguiferous System.

III. In those of the Alimentary Canal.

These are often in peculiar circumstances, but in what these consist is difficult to ascertain - These different sets of Fibres are common to 3 different kinds of functions, the Animal, Vital, & Natural, tho' these seem to have a common connection with the brain yet it is in different degrees & without our being able to conceive wherein this mutual dependance consists. However we may avoid this question in the Physiology, it will nevertheless constantly recur upon us in our Pathology - as we find these functions are the seats of classes of diseases, the seats of Hysteria, Epilepsy, Fever &c & these perhaps depend on the peculiar structure of the Organs connected with them, and on this account we would wish to make a progress in the Investigation

investigation of their peculiar structure. With respect to the Organs of voluntary motion their Tension depends chiefly on the Antagonist muscles and the weights they occasionally sustain; These weights indeed vary in the progress of life, but are very little different to give occasion to the various states we find the Muscles in — there are indeed many external means of giving Tension variously applied to these Muscles, as habitual ligatures pressure &c. which may vary their tone and variations in these have often influence on their tonic power, but these cases are few and seldom bring on these diseases that affect the Organs of voluntary motion; we must therefore seek for some more probable cause.

They are not exposed to external Stimuli, only to Stimuli acting in the brain, to propensities, volition, and other motions first begun in the Brain and from thence communicated to the Muscles, and thus the action of the brain is more strongly excited in the organs of voluntary motion than in the other muscles, and hence I endeavour to explain the effects that the Action of the Muscles of voluntary motion have in producing sleep, and they are liable to be affected by those causes which produce great changes in the excitement of the Brain. The Action of the Organs of Involuntary motion

motion is excited in the Brain in consequence of unusual Stimuli, and Stimuli applied directly to the brain itself are the most frequent causes of convulsive motions in these organs, and what is remarkable is that the more frequent causes of extraordinary Convulsions are those motions that most strongly induce a collapse of the Brain, thus Fear, Hemorrhages &c. almost constantly produce Convulsions, and poisons induce a considerable, first perhaps by acting on the natural functions. Some of these may be direct Stimuli, but most of them are direct Narcotics, and it is then they produce Convulsions of the Organs of voluntary motion & we see in Epilepsy &c., and upon the whole the causes which produce the most considerable changes in the excitement and collapse of the brain are those that affect the Organs of voluntary motion.

I go on to mention the muscular fibres of the Arterial System that are principally concerned in the Circulation; these are liable to the most varied and unequal tension - this may depend on the other solid parts of the body and may affect changes in the length of the Arteries; but this we may pass over as liable to little variation - the difference may be chiefly by varieties in their texture and in their circular fibres - the only stretching powers applied

applied to these is the impetus of the circulating blood where they must be liable to inequalities, as the quantity of the blood must be considerably varied according to the quality and quantity of the Aliment taken in and according to the different powers of the chylipoietic viscera as more or less is converted in Sanguinem & Succum; the proportion likewise between the ingesta & egesta will have considerable influence; from all these considerations the quantity of blood appears to be very variable, and consequently the tension in the Arterial fibres and the quantity of blood being given the force of the blood will be as the impelling power of the heart and Arteries. We may judge by the bulk & the weight of the heart with respect to the System, but this will depend much on the state of the brain which gives occasion to very different actions of the heart. In so far as the state of the Brain depends upon the fullness and tension of its vessels, it is much more liable to have this in the forepart than in the latter part of life. As to the various external pressure to be moved by the various extensions of an Artery these are causes acting occasionally every moment of life. — Other causes are the distribution of

of the blood, different in different periods of life. In young people there is commonly an Arterial, in old a Venous Plethora. We know that the resistance in the body is greater in youth than in age; the Arteries from their having more pressure have greater quantity of blood to overcome this resistance, and hence have a greater degree of tension.

I observe that in the Arteries the blood is distributed in different quantities to different parts of the System in different proportions in the various periods of life. Arteries are framed in some parts to be larger than others in different times of life. The Arteries of the head in young people are larger than those in the legs, less so indeed in old people, but are evidently larger. This will explain the different degrees of Tension in different parts of the Arterial System in the progress of life. As Muscular Contraction is a stimulus to the Brain it must have considerable influence on this Organ, in proportion to its different degrees of Tension, and the Brain again must have the same on the Arterial System. The difference of Tension taking place in the Arteries depends on the fullness or emptiness of

of the vessels, and to the different states of this their tension will always be proportioned. The Arteries may be considered as Chords having their end at the heart always fixed, and we may consider the blood as especially applied to stretch out extremities, and the stretching will be determined by the fullness of the extreme vessels. The resistance and tone of the Arteries is in proportion to their tone & contractility as simple solids, and hence we may suppose this as always given. Many of the Arteries lie superficially, have their extremities on the surface of the body, and hence may be affected by many causes. Their tone may be increased by the compression of the Atmosphere, and its variations will especially affect the extreme vessels on the surface - but this however plausible at first sight is not a cause of so much influence as has been imagined. But there is another cause, viz, the various temperatures of Heat and Cold, which gives a greater or less degree of Contraction to these Vessels.

We yesterday considered the different states of Muscular fibre, as their inherent power in particular parts depends much on the state of Tension,

so we can perceive these fibres to be in very different degrees of Tension at different times & in different states - 2. As muscular fibres are affected by habit, and some have been often subject to repetitions of exertion, so these may have acquired a peculiar degree of vigor and mobility. Some of these too are more exposed to stimuli than others. The state of the moving extremities is various, some are exposed more to the action of the brain than others, and have their influence especially from the Brain - This is the case with some muscles united together in the exercise of the more general functions or those of voluntary motion.

2.^d State or those of less dependance on the brain occurs on the moving fibres of the Arterial System - 3.^d The muscular fibres of the Alimentary Canal concerned in the principal parts, of the natural functions - These are liable to separate affections, and of course are the seat of peculiar disorders.

1. With regard to the Organs of voluntary motion. These are not liable to a great variety of changes in tension, as this state is pretty well kept up by the Antagonist Muscles, are however variable from the circumstance of external pressure ap-
plied

plied to them, and having been accustomed from
have this constantly applied to them. When
this is removed we can understand why they
should lose their tone. I suppose the peculiarities
with respect to the organs of voluntary motion
are owing to this that they depend more
especially on the brain, and are not like the vi-
tal and natural dependant on Stimuli applied
to the Muscles themselves, but by propensity &
will which require an energy of the Brain,
and it is hence that I endeavour to explain that
Collapse of the Brain which takes place in
Sleep, as depending principally on these Ani-
mal functions. These Muscles are liable to be
affected by such causes as change considerably
the functions of the Brain, and thus strong
Stimuli applied to the Brain produce Epilepsy,
which stimuli will be proportionally stronger
when applied more directly to the Brain itself.
This is quite consistent with the exercise of
voluntary motion, dependant on the strongest
exertion or action of the organs of voluntary
motion by means of the Brain. But the same
motions are excited by all the powers that
produce strong Collapse of the Brain, as
Fear, large Hemorrhages, & Narcotic Poisons.

This

This I offer as a fact which I shall not attempt to explain. These however show a particular connection of the Organs of voluntary motion with the Excitement and Collapse of the Brain.

2. We now come to the next head, the Arterial System, which consists of Muscular Fibres capable of great inequality of their condition, for their action depends on a Stimulus applied and regularly renewed. This consists in the impulse of the circulating blood - that this is liable to great inequalities is obvious. It depends on the force of the heart acting by various causes with a different Momentum. The tension of the Arterial System will depend on the blood being in greater or lesser proportion in the Arteries with respect to the Brain, and there will be some difference with respect to age and these conditions which give a less irritable fibre - they will likewise be influenced by such causes as act on the simple solid, and by causes which acting only on the Arteries may give them a different tone. We can hence perceive that the whole Arterial System and different parts of it may be in different states of Tension. I observed that the Arteries may be considered
as

as a Chord stretched between the Arteries and their Extremities, and it is upon the Extremity only that the variety of Tension must appear. Hence the state of Tension may be varied by the fullness or emptiness of the extreme vessels, every where dispersed on the surface of the Body.— The fullness and emptiness of these extreme vessels will be as the stretching powers and the resistance taken together— The resistance depends on the tone of the simple solid and Arteries themselves. In the Arterial System we may consider the state of the simple solid as always given. The resistance of Arteries do not depend on the simple solid alone but also on the moving fibres, and those in the extremities may be varied by causes applied to them alone. It is necessary here to observe that the most numerous Arteries are to be found on the surface of the body. It is here we can see that it must be applied to a great variety of these— it is here that external pressure has a share in the tone of the Arteries. The pressure of the Atmosphere will be first especially especially perceived, this however is not considerable either in its variety or effects— They are liable to much greater variation from Heat and Cold

cold, and hence it is that they are liable to different states of Tonic power. The Skin is an Organ of Sense the most considerable of extent, of any of the System, and hence so far as excitement and collapse are dependant on each other, this Organ must be liable to the different changes and conditions that affect the Brain. The stretching powers are so applied as to begin first in the larger Arteries and then proceed to the more remote extremities - hence they will be affected more or less as they happen to be more or less near to the heart - Of this general principle we have an excellent example that upon the diminution of the heart's force the feet first become cold, and when Sweat is brought on by an increased action of the heart it is last of all in proceeding to the most distant parts especially the feet. This tension of the Arteries is extremely variable, every variation in this state of Tension must appear in the extreme vessels every where. But the change in the tone of the Arteries themselves will be more often on the surface than else where, as depending on the force &c. There is this also to be added that the skin is every where a continuous membrane, whence the effects will

will often be diffused all over the surface. In the last place from the surface of the body being considered as a very large part of the Nervous System - it must be liable to great changes from changes in the Action of the brain and the Action of the Heart, and changes arising from several causes affecting the surface must produce considerable changes in the Nervous System and also in the Distribution of the blood. The Connection of the surface of the body and the brain and action of the heart and arteries is a fact whch has been neither sufficiently explained or attended to.

3. The moving fibres of the Alimentary Canal and more especially of the Stomach - Nothing is more evident than the connection of this viscus with the brain and the whole of the Nervous System; but at the same time this connection is so evident, an essay towards its explanation will be found to be one of the most difficult problems in Pathology. This viscus is supplied with Nerves in a larger proportion than any other part of the body, and to render this of a peculiar Sensibility it has a considerable connection with the brain and nervous System, and hence it is more liable to be affected by changes

changes in the Brain, and the changes in this Organ in its turn affect the Brain - it is doubtful however with respect to it whether something may not depend on another circumstance, that the actions that depend upon Stimuli are performed without the action of the Brain intervening, or a less considerable one than takes place with regard to some other powers. But even where these are capable of exciting the action of the Brain, the influence will be less considerable than the Animal functions. These actions then in common go on without Consciousness, but if excited a little more strongly they excite Sensation, and thus probably it is that they have a concurrence with the Brain - hence we will say that this may be more considerable as performed with more inequality and of course it will be more liable to occur in the Stomach and intestines than in the vital organs, as the Heart &c. These are it is true liable to some inequalities but these are of short duration. The Stomach on the contrary is liable to more considerable vicissitudes. We must manifestly perceive this in the action of the Stomach,
after

after a full meal, and upon comparing this with the action of the same viscus - when no aliment has been received for a considerable time. It is this vicissitude that gives it's affections with respect to the Brain, and the Brain is of course accustomed to much difference of action with respect to it. So far we can observe, in consequence of it's action, a change in the tone of the Brain. As an Organ of Sensation it is liable to great variety of Impressions. The Heart and Arteries may be exposed to Stimuli, but this is but inconsiderable and accordingly there is a doubt whether ^{such are} subject to any Stimuli but the blood - now the food acts not only by it's bulk but also by it's peculiar qualities, and in proportion to those stimulates more or less with respect to the System. But the food after being taken in produces Stimuli of another kind - and other matters introduced have a power of checking the fermentations producing or encreasing these Stimuli. Thus we see that whilst it is an Organ of considerable Sensibility it is besides exposed to stimuli in great variety in proportion to the number of Nerves - there ^{are} not any that are liable,

liable to so much influence from Stimuli as those in the Stomach.

I have to add that besides these more general classes of functions, it is ^{to be} observed that there may be separate portions of these liable to be affected by particular causes separately. The Organs of Perspiration can be affected with Spasm, as in an Asthma, of the Sanguiferous System some Vessels may be affected with Hemorrhage whilst the other parts show no such disposition and those of the Secretory and Excretory System are liable to a separate affection. — The intestines may I think be affected separately and in their different portions, but I leave this till we come to the Pathology. From the whole it will appear that the moving extremities are in the different states of Excitement and Collapse, and the Brain being subject to the same they will have mutual influence on each other.

CXIII. Upon any supposition this Conclusion will follow that there is a mutual pressure between the origin and Extremities of the Nerves

Nerves and that this is constant. Every body will acknowledge that there is a body along the sensitive nerves to their origin, and I have endeavoured to prove that there is a motion also from the origin to the extremities, and that the same extremities are at once the organs of sense and motion. This is explained on the supposition of a secreted fluid or any other Theory that Physiologists have adopted; but these opinions I have refuted, and presume I have shown the notion of a fluid by secretion to be incompatible with the Phenomena of sense and motion. I shall in some subsequent Lectures deliver my own opinion, which I imagine will be found at least more probable and adequate to the Phenomena.

I now go on to consider more of the Laws of the Nervous System relating to the Brain.

CXIV. I am now to consider the various causes of the different states of Mobility in the Nervous System. I need not inform you of the difficulty attending this investigation, but it unavoidably presents itself in every part of our Pathology. I shall therefore attempt it, and shall be cautious both in the ascertaining of facts and in the induction of causes

causes. I only propose to lay down certain facts that must engage us in Speculation, and this must be done if we touch Pathology at all. I have again repeated the definition of Mobility, it is the facility with which either Sense or Muscular Contraction is excited. Vigour is the force whereby Muscular Contraction is or may be performed. With regard to Mobility or the facility with which these are performed, it is often connected with this last, so that this last is often exactly in proportion to the facility of Sense. I cannot always determine when it is most in the one or in the other, or when in each alone. Having thus ascertained the notion of Mobility I say that the Excitement of the Brain may be considered with respect to the two states of Vigor and Mobility - but these are in many instances opposite to each other. Vigor occurs when Mobility is less - The Mobility is less in a male Adult than in a Woman or Child. In Maniacs and Melancholics there are many instances of unusual vigor, but with little Mobility, being capable of resisting the most powerful Impressions. There are maniacs that have mobility to a great degree and frequently in different respects, but in general they are insensible to any but the most powerfull impressions

Impressions. We have this further confirmation for alleging that the states of Mobility and vigor are opposite, that vigor is connected with firm dense and rigid bodies, Mobility on the contrary with weak and relaxed. You will readily see the Application of this in age sex or temperament, but at the same time when this rigidity and laxity appear in the simple solid vigor and Mobility appear in the Nervous System, and hence I infer that the state of the Simple Solid does affect the Nervous System, and that the Medullary Solid undergoes changes analogous to those of the simple solid, and is more or less correspondent to the state of the Simple Fibre. The tonic powers that induce vigor, so far as we know them, are for the most part Astringent ones that condense the simple solid and thereby take off Mobility and strengthen the simple solid, & this has great effects in communicating strength to the Nervous or Medullary Solids - As this is opposite to Mobility we can see that Evacuations & want of the usual pressure are causes of debility, but it is likewise as commonly supposed that a certain state of tension gives also an increase of Mobility. To remove this difficulty I would say that

that tho' I am not to enter upon the consideration how far mobility and vigor depending on different considerations may be produced at the same time and by the same cause, hence Tension might ensue, but I would say that there might be only an appearance of Mobility. For Vigour being in proportion to the tension if the proper Stimulus be applied it will give an increased action wch might look like Mobility. But whatever might be in this, that larger Oscillations be will appear more considerable in very lax fibres, we might add further that if laxity is disposed to produce Mobility there may concur the greatest irritability, and hence the Oscillations be more quick and convulsive. But these large and more violent contractions will appear more especially if the cause of Tension be liable to great inequality, such as the distension of fluids depending upon impetus and quantity, & this more especially in the Arteries wch give an appearance like an increase of Mobility. I think this appears very clear and will serve for a solution of many of the Phenomena, as why a case Arterial System in a plethoric state should always appear a moveable one, and hence too we may see why it sh^d be

be liable to Hemorrhage or Inflammation. There is much more however in this consideration than what relates merely to the Arterial System. Every lax fibre under tension is liable to it, hence a full Arterial System may give the brain more mobility than it gives vigour, & thus a full Arterial System which takes place under a certain degree of laxity may give Mobility to the System in general. Hence a tense System proves a moveable one, and a hemorrhagic System attended with the same facility of excitement; The whole of this will apply to the Muscular Fibres in every part of the System, their tension depending on the numerous Arteries surrounding each fibre. Every Muscular fibre is exposed to a variable tension as well as the Arterial System: Another reason why from a state of tension, the part may appear more moveable, that we understand why the Alimentary Canal can be affected by the state of the blood vessels in a plethoric habit, as their fibres may acquire the appearance of real and great mobility. This is the reason why hysteric cases so often occur in sanguine and plethoric habits, and the Muscular fibres of the Alimentary Canal are liable to be affected by a partial plethora of the Uterus as well as of the whole

whole system. I go on to illustrate the subject by the consideration of certain other causes. All strong sensations if not to excess give vigour and obviate Mobility for the time they are acting [such as keen desires and moderate pain &c.] but these ceasing they are remarkable for inducing Mobility in the system. This is an illustration of the first position as to vigour & Mobility, being in some measure opposite.

Heat excites the system, but there are some circumstances which make me conclude that it gives Mobility more than vigour - Every increase of Temperature from below 62 deg. does manifestly increase vigour, above 62 deg. it appears to relax the simple solid, and above this standard the nervous fibre acquires greater Sensibility, and hence these increases of Heat produce greater debility and sometimes mobility; on the other hand the operation of Cold is more simple and obvious, as it condenses the simple solid and contracts the moving fibre - to a certain degree it increases the tone of the moving fibre, hence we may understand why it gives vigour and destroys Mobility, and hence too we see why in excess it gives insensibility (and

and debility, by the insensibility it produces it, always takes off Mobility.

II. Narcotics. Their effect is to destroy vigour and sensibility & by this means destroy Mobility - they also induce a Torpor on the moving fibre - it is also to be observed that they have this effect only during their operation, for when this has ceased they leave the body more weak, irritable, and moveable. Most of the causes hitherto mentioned seem to act on the Nervous power, tho' not producing a change in its condition, these others seem entirely to affect its mobility - thus attention to one object diminishes that Mobility to other objects that would otherwise appear. Green desires &c. seem to operate in the same way, but here the connection of circumstances is curious, it appears that it is vigour that renders us capable of fixt attention, and this is more or less as the vigour or debility of the System is at the time. Attention can be more fixed in Men than in the moveable Constitution of Women & children. - Whilst attention depends in some measure on Vigour it takes off Mobility and by this means renders us more capable of attention, hence Melancholics are capable of the most fixt attention, which

which is a circumstance peculiar to this species of Mania.

Fear is in its direct tendency a cause of debility and a frequent cause of great Mobility— but this is of an immoveable kind, for a constant dread of an impending evil, there is nothing more powerful in obviating mobility, and hence in removing Spasm and Convulsion. It is in the same manner that an obstinate Grief gives Insensibility, as every anxious attention does. Thus a delicate Woman that could not bear to be exposed to cold or lose her sleep, will when her attention is taken up, for instance with a sick child, bear all this and much greater fatigue with none of those consequences that would otherwise follow. Want of Mobility thus favouring a more fixed attention and thus arresting the motions of our System, shews us that the Nervous power may have its influence suspended for a length of time. This may give us some idea of the Letatic and Cataleptic states related by Physicians, but as this is a rare occurrence we cannot prosecute the subject not having sufficient facts to attempt a tolerable system with regard to it.

There is a state of Mobility that is connected with

Gaub. Pathol. 199.

with vigour, viz, that Mobility which is acquired by repetition or habit, and may affect any particular Muscles, and thus these may acquire both vigour and Mobility at the same time. The Mobility that occurs in every particular person is truly not so dependant on the more general causes, but more determined by the powers of habit. I have said that frequent exercise increases the tone of every Muscular fibre and also the Mobility. Dr. Gaubius therefore reckons among the causes of debility the want of motions. I think Dr. Gaubius is not correct, there is something more than the defect & excess of the vis vitalis; the insensibility of Maniacs does not depend upon a defect of this vis vitalis, nor does the Mobility of children depend on an excess of it.

In 17th there is a mistake of the same kind. In the Stomach the Mobility may be increased while the Sensibility remains the same. when 5 gr. of Specac. nauseate a child & won't have that effect upon a Man it is possibly owing to the different Sensibility, but when a man by repeated vomits will be readily moved by gr. v, this is a facility in the moving fibre. Mobility is to be considered as different with respect to sensibility and irritability, and they must be considered in many cases as

as separate and distinct.

Having before mentioned the various states of Mobility I now proceed to say something on excitement.

CXV. This is seemingly a paradoxical opinion & a proposition not easy to conceive, how much therefore must ~~we~~ be embarrassed in the explanation of it's causes - we shall therefore proceed with caution in forming general conclusions that may influence our pathology. A sense of Pain is always attended with a propensity to avoid the painful sensation or cause of uneasiness, and this propensity produces motions in the body suitable to remove the painful sensations. This fact may be easily admitted and we say more generally that as the motions produced differ according to the place & quality of the impression there is a difference between the Impression and motion produced. As the intervention of propensity seems to be an operation of Intellect directing motions and perceiving causes as to the ends to remove them not mechanically tending to affect this, but intellectually. Here we have taken the supposition most favourable to the Stahlian system. The Stahlians never in the least doubted of the general laws I have laid down, that the causes of collapse prove occasions of excitement; however I meet with great

great difficulty in admitting their doctrine of propensity, because the motions here produced are altogether involuntary and against the inclination, and surely when the motion of the Will is not interposed they are instinctive without reflexion on the end to be obtained, or even consciousness of the means we employ. In the perception of causes if experience instructs us to observe the end to ^{be} produced, yet we are unacquainted with the means and seldom foresee them - these we before illustrated by particular examples. From these considerations therefore we reject the operation of intellectual interposition, we must have recourse to a mechanical connection, not guided by marks of intelligence and reason, and if this mechanical connection takes place in sensation there can be no difficulty in admitting it in Stimuli which produce sensations adequate to the removal of the painful Impression. If we say with Dr. Whist that the motion may be communicated by means of a sentient principle, yet it is not guided by marks of intelligence and reason as in the case of irritation in the Stomach and Intestines which produce motions sufficient to remove the Stimuli that otherwise might be hurtful to the System. —
Bodies acting in the Stomach produce nausea, i.e.,

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a Propensity, but here they often operate before they produce the Nausea, but the whole effect is in increasing the Action of the Intestines & promoting the secretion of the fluids, but propensity is not brought on till after the effects are produced - but to explain it more fully. - A purge taken into the Stomach irritates, immediately a copious secretion of fluids ensue to prevent any noxious effects from this stimulus, here then is an effort of the System that we are by no means conscious of and can therefore never be by the interposition of a directing intelligence - the propensity or conscious effort to remove these out of the body does not take place till the bad effects of the Medicine are counteracted, so that the intermediate state between the receiving and the accreting the substance is taken up by Salutary exertions of the System, that we are not in the smallest degree conscious of either, of the means employed, nor the end to be produced. Here are then cases of Stimuli producing motions to remove a stimulus that we must refer to a Mechanical Connection between the motion and Stimulus. These are

1. The increased action of vessels pouring out fluids to wash off the Acrid matter or to correct it.

2. Where

2. Where the motions consist in the action of muscular fibres whose contraction by a mechanical impulse can throw off the offending matter.

Though applied to certain portions of them only, they may also operate on those contiguous to them. We don't then perceive whether the Stimuli are applied to the Muscular fibres themselves or to certain sensible Membranes contiguous, from whence being communicated to the Muscles Mechanical Impressions are excited that throw off the offending matter. Emetics excite motions in the Diaphragm and Abdominal Muscles tho' they are not applied to the Muscular fibres of the Stomach or of the intestines, but are applied to the nervous extremities in the villous coat and from thence penetrating to the Muscular, this latter being exterior to the others. Here then is a considerable distance between the place of Impression and the place of Action, and 'tis probable the connection here is Mechanical. I now go on to observe that this connection between Impression and motion does not only take place with regard to the impression of external bodies, but it happens also in those internal impressions that take place in sensations of Consciousness - the usual distension of vessels or other Cavities may be considered as

as Stimuli as external Impressions - Many Sensations of Consciousness arise from want of Impressions, from a diminution of Excitement, from an increase of Collapse. If sensations so frequently produce motions, all the reasons I have employed to prove that motions are excited between the Stimulus and the action excited for its removal will apply in the one case of Mechanical Connection, they will surely as well apply in the other. Any thing relative to the Modus operandi I cannot attempt to explain from the small insight we have into the subject, it cannot be expected - probability is at the most all we can aim at, and if our theorys are found more applicable in Pathology, they may with propriety be retained, if useless and inapplicable let them be rejected. I formerly considered the action of cold as a Stimulus, tho' in its direct action it is a cause of Collapse and acts by a diminution of excitement, tho' in its material operation it produces Collapse yet it acts indirectly as a Stimulus and is an example of what we spoke of in other Sedatives who produce Stimulant effects in their direct action, yet by the effects and reaction of the Sensorium excited they prove considerable

-derable Stimulants, so that this depends more on Sensation than Impression.

Acids tho' they are Astringent and Sedative yet are often Stimulants, and Neutral Salts are both Sedative and occasionally Stimulant. There is more difficulty with respect to Neutrals than Acids. The Neutral powers of common Salt are active, but I am dubious of its Sedative operation. The Sedative power of Nitre is remarkable, but it is Stimulant in the Stomach and Urinary passages and most of the Neutrals possess this duplicity of Action.

A 3^d instance is in Narcotics, where we observe the same combination of Stimulant and Sedative effects. They stimulate the parts to which they are applied and they never operate as Sedatives without their Stimulant powers first appearing - so far do we find this combination in Acids, Neutrals and Narcotics, but it is uncertain whether the Stimulant power depends on the Sedative, which is what I want here to establish; in the same substance there may be seemingly the same power tho' different in operation - They may have by Compression the effects of Stimulants tho' by acting on the Nerves they may have a Sedative effect. - Our Conclusions however are supported by

by other considerations of less ambiguity. There are two cases of Collapse producing excitement which admit of no suspicion of their being combined with a Stimulating power,

1. Fear, every Phenomenon^{shews} that this is directly sedative, but its effects are frequently Stimulant producing colour anger epilepsy &c. It is according to the moral purposes of our Economy that Fear produces excitement, and if there be with these mental operations any thing Mechanical concerned it must be allowed that a state of Collapse produces a state of excitement. When I mentioned instances of increased motions in particular parts, as in palpitations of the heart arising from various causes, from quick respiration, increased muscular motion, from various resistances, from the blood being freely evacuated from the heart, in all these cases we can say it proceeds from Stimuli directly applied, but where it arises from fear or Syncope it seems to proceed from Collapse producing excitement and increasing the more vehement action of the heart

Sudden and great Hemorrhages produce Syncope, and all other marks of Collapse, & Death, but they never produce Death without Convulsions

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and Epilepsy. Dr. Hales observed that a little before that period the Animals that he bled to death became Epileptic and Convulsive. There is from this degree of Collapse a state of the system that necessarily infers a degree of excitement, but this will be further illustrated that there are other causes acting in the same convulsive and epileptic manner. Narcotics are moderately stimulant in small doses (admitting their action here as direct stimuli, without reaction &c.) but it operates by producing Convulsions and Epilepsy, only when thrown in in large doses. When Death is coming on the same effects appear as in Hemorrhagy, and they are analagous so far that in both the state of excitement follows the state of Collapse. You know the noted case of Epilepsy, when it arises from a distant part and gradually approaching to the head that then alone it produces Epilepsy, and that by inducing Stupor vertigo dimness of sight and all the marks of Collapse, and then all the Epileptic motions in consequence of this. From all these considerations it appears that whilst Convulsions and Epilepsy may be merely in consequence of Fear, Hemorrhage
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and other Stimuli, yet they operate by causes first introducing Collapse, and the Animal Economy is so formed that a certain degree of Collapse necessarily produces a state of excitement. As there are so many instances of powers tending to hurt the System, and as there are motions excited in the Economy to counteract the hurtful tendency of such powers, we might continue on the Analogy and say there is the same provision with the powers respecting Collapse, and the provision made in this case as in the other where something depends on the peculiar organ that provides for its defence; hence we may conclude as in the proposition, and I shall use a term for this counteracting power, viz, the Preaction of the Brain. All the operations of the Brain may be called it's Preaction, but I will limit the term merely to it's action in opposition to the causes of Collapse.

We must here consider that it does also take place with respect to particular parts (where the brain is little concerned) as well as to the whole. Cold may produce Hemorrhages and Inflammations purely Topical, and I have
instances

instanced other local affections such as palpi-
-tations of the heart, that whatever tends to
prevent this and weaken the action of the heart
proves a more violent cause of excitement.
Further, to prove how far such circumstances
may be local and mechanical we can un-
-derstand their operation in the inherent power
of the Muscular fibre. We find that Cold whose
operation is only to diminish motion, yet
this operates as a Stimulus on the heart when
entirely separated from the Body - hence I
conclude that there is something in the
nervous power that whatever tends to dimi-
-nish its mobility or motion produces its
excitement.

CXVI That the Action of the Brain is determined
and regulated by custom & of consequence all
the motions of the system, is a proposition with
few would dispute. But hitherto it has been
only generally observed by Philosophers who
in treating of the effects of habit have men-
-tioned it in very general terms, but wherein
it more particularly consists, and to what
particulars it more generally extends, and
how far it affects other causes that influence
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us has as yet by no body been explained. If I can accomplish this I shall think myself very well employed. I just touched on the subject before but shall now consider it more fully, and reduce the whole into one united and connected view.

With this view I consider custom and habit 1.st as influencing the sense, and 2.^d as influencing the motions of the body.

With regard to it's influence on Sense.

Custom determines the Sensibility of the System with regard to the force of Impression. A state of the force of impression gives a corresponding state of Tone to the sentient extremities of our nerves, ^{which} when they have been accustomed to certain degrees of force of Impression which as before observed produces a correspondent state of tension that renders them insensible to the action of weaker Impressions. This holds in the operation of heat and light, heat & cold, & other instances of the same kind, as we observed in Prop. XXVI. our Sensations are correspondent to the degree of change produced in the sentient extremities of the Nerves.

A 2.^d effect of custom is that Impressions lose
considerable

considerably of their force by repetition or rather the Sensibility of our System becomes less sensible with regard to them. There are many well known facts to corroborate this assertion, but it is likewise a fact that certain motions by habit are excited with greater facility; whether this is an increase of motion or increase of Sensibility in the System I shall not explain. It seems to me that this law is connected & perhaps entirely depends on the former, for if an Impression that has subsisted for some time gives a certain degree of Sensibility, yet the Sensibility of the System will gradually diminish and at length it will become totally insensible till excited by a stronger force of Impression.

If I give a Man 2 grains of Tartar Emelic & it produces not the least effect, the tone of his Stomach being adapted to 2 grains, but if under the same degree of Tension I give him three grains, that being sufficient to change the tone of his Stomach, has it's effect. If I continue to give him 3 grs for any length of time, by habit the tone of the Stomach is increased so as to be adapted to receive three grains without effect, and to promote the operation I must still increase it.

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I go on now to mention a 3^d law relative to the effects of habit, that custom associates Ideas together, so that they are never singly the objects of Perception, that whenever a particular Idea is in the mind, it always is immediately succeeded by an Idea relatively connected with it; this is the cause and foundation of our Memory. You will recollect that the foundation of Association is that 2 Sensations having been present at the same time or immediately succeeding each other, however unconnected the Ideas themselves may be, yet they are notwithstanding associated together by Memory, their merely having been together is sufficient without any other relation for their returning again together into the Mind; by the Association of simple Ideas, complex Ideas are produced which are the sources of our knowledge & the chief advantage we possess above other Animals, but it is further to be observed that the Association is stronger as the Ideas are marked by any kind of relation, and the force of Association in respect of this circumstance is very different. Memory will associate relative Ideas together that have never been combined nor ever appear immediately successive in the mind, yet if there is
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the least relation the memory will renew it, or rather bring it in view with an Idea that it never before was combined with. If I to day see a Man 8 feet high the sight of so extraordinary an object will make an Impression on me, if 2 days after I should meet with a man of a complete age only two feet in height this must likewise make an Impression on me & w^d immediately recall the Idea of the tall man, nor could recall the Idea of the one unassociated, the other w^d be immediately successive in the Mind; this could not be done but by the Contrast that subsists between these two Ideas, they being in themselves so directly opposite that the Mind w^{ch} frequently is more conversant in extremes than perhaps in the other relations that are less distant, immediately on the recollection of the one the Idea of the other is opposed to it, & this is a comparison of objects very remote from each other tho' generally resembling. These are the powers of relation which are so far influenced by custom and habit that unless they undergo a frequent repetition they lose considerably of their force and are forgot altogether. Habit & repetition thus associates Ideas, and it determines

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the order & succession of them when combined.

1. Our Sensations are not made up of a numerous Series, but they arise in a certain order & succession & cannot be recollected without the exactest adherence to that order, the least interruption in this order throws us into confusion, we are also by the power of habit determined to follow this order with a certain velocity in the succession of sensations. If a Man is pursuing a certain train of Thoughts & is interrupted by any means, he immediately loses his train & finds himself obliged to begin the train again before he can proceed any farther. If likewise (independant of any interruption) he should pursue this train and speak with more velocity than usual, he is very apt to lose some part of his train & must begin again. Another circumstance regarding this is that a facility either in speaking or thinking in our usual train is agreeable, as any change or disorder is disagreeable & uneasy. When we have observed the powers of habit in determining the train of our Ideas we find every man is subjected to this habit.

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and has an usual & uniform train. Our life is a routine and repetition of actions of the same kind, eating drinking sleeping and all the recreations are always recurring on us, with some variety indeed but for the most part regular. A man is occupied in one employment and is conversant with the same external objects, is confined to one house & connected with a circle of people following employments of the same kind with himself. In all this there seems apparently great variety, but with the variety we shall find a mixture of uniformity which is the most prevalent in human actions; for this we might find an application on the subject of delirium, but here it would be inconvenient as it wd prolong the subject wh is already spun out to too great a length. We have now gone through the several laws of habit with regard to Sense, we now consider these powers with regard to the motions of the System. I observed in the 9^a Prop. that custom & repetition gives more force to particular actions; it affects these by determining the state of Tension necessary to the Action of Muscular fibres; it is certainly necessary in determining the degree & even encreasing the Tension, but it is not absolutely so in giving Tension. I think it is an uncertain point.

point whether all the laws relative to the influence of the Brain do or do not entirely belong to the simple solid, or whether the powers of habit or more repetition have not a considerable share. So far is certain that the influence of custom is very observable with regard to the simple solid, as to the degrees of motion that the particles of the solid admit of on one another we shall endeavour to illustrate this by a particular example, take a Chord of 9 Inches in length, if we would perform Oscillations upon it it must be extended, let it be extended to 9 inches & a half, if then flexible powers are applied it will perform vibrations and will contract to its former dimensions on removing the stretching powers, but if this Chord is extended by proper force as far as 10 Inches & allowed to remain in that extended state for a considerable time we shall find on the extension being removed the Chord will contract, but not to its former dimensions, viz, 9 Inches, & it has now so far lost its mobility that it will require to be extended to 10 Inches to perform its Oscillatory motions. Therefore the tension necessary to the action of the simple solid is determined by custom and habit. The degree of tension however that a simple fibre will admit of

of is determined by the same power but in a different manner; we shall likewise give an illustration of this, If I take a Chord of 9 inches in length and extend it to 9 inches & a half tho' it will admit of being extended to 10, but if instead of stretching it to 9 & a half I stretch it immediately to 10, then the power that wd have bent it at 9 & a half will not bend it at 10, but by practice it will readily do it, that is if the stretching powers are frequently applied it will acquire more mobility & flexibility from this as it were repeated exercise; therefore by increasing or diminishing the Mobility of parts upon one another we can determine the degree of Tension necessary to the action of the simple Solid, for the Action of Muscular fibres are governed by the same laws & circumstances in the dead as in the living body, & the degree of extension that either of them are capable of is determined by habit. Whether this is a property of the simple Solid or of the organized fibre is unnecessary neither is it our business to determine, for my own part I should rather imagine it to be a property of the latter. If a Man who has been accustomed to a tool of a particular size & weight should attempt to use one of a smaller size and less ponderous

ponderous one that gives him less extension, he cannot use it with that degree of steadiness that accompanied the use of the larger tool; from this it is evident that a certain degree of Tension is necessary to the action of our several muscles regulated & determined by the powers of habit and repetition. This extends to a prodigious number of actions of our System, and will be found to be of very general application. It seems also to explain the vacillation and debility that ensues on taking off the tension.

2. I now come to the 2.^d Law.

Motions are associated with Impressions that become necessary to the performance of such Actions, tho' no otherwise connected with these Actions but by being repeated together. I shall give you a very singular example of such an Association of Impressions & Actions. A Woman with child had a great inclination for a new gown which being made & just going to be fitted on her she immediately turned sick, the next day the gown was tried on again but she fell sick a 2.^d time (tho' the gown as an impression was by no means the cause of her sickness, yet merely from the connection recurring of her being sick when

when the gown was tried on from the gown being connected in point of time with the cause of her disorder, it really brought back the cause upon her, & she was ever afterwards sick at the sight of that particular gown]. - There are a variety of instances of the same kind, I shall mention another instance of the Association of Actions & Impressions by habit, in the case of making water when we go to bed which constantly recurs upon us at that period even when the usual quantity of Urine is deficient to give the stimulus. This association of Motions and Impressions is but a part of the Association of Ideas mentioned above. In motions this is particularly curious from the circumstance of the recurrence of the stimulus without any visible exciting cause, yet the sensation from the associated circumstance of going to rest is excited & exactly referred to the same part; this is difficult to explain, but the renewal is properly in the Brain, there is certainly a retrograde motion determined to the particular part, but if it is not allowed that Association is produced in consequence of the Brain there my doctrine of mechanical connection may seem to be disturbed, but it is not in the least affected, for Sensation in consequence of a motion in the brain has

has all the effect of Impression in producing Action, and the renewal of a Sensation in the Brain has all the effect in renewing the action first, made by the power of Impression, but on either supposition it will help to explain at least to show the effects of Imagination, that is the renewal of Sensations from Association.

3. We now proceed to the 3^d Law that custom associates different motions, so that they cannot be separately performed. We have the strongest proof of the inseparability of such motions by habit, as the motion of the 2 Eyes, the sensibility of the Iris and many circumstances of that kind. With regard to the first instance there is nothing in the structure of the parts that sh^d make those motions synchronous, they are different Organs & are merely inseparable in their motions by habit. We know that no motion of our body is performed single, they are all complicated, even the slightest motions that we make are performed by the concurrent action of a number of Muscles; now in these complicated actions many parts must be moved together at the same time & in consequence of this repetition they are determined to an Association & connection by the powers of habit. These Associations

Associations seem to depend on the Will, but the Will we know is not always intelligent in directing the several motions, for on our first endeavouring to perform them we don't do them with that steadiness that sh^d accompany the performance of them, we go about them awkwardly, & the will, so far from a perfect intelligence, betrays an ignorance of the proper motions by substituting others that have no connection with them, & is not so much as acquainted with the means of performing them; all actions are at first ill performed, for 'tis by repetition that they become more firmly associated, & this without any regard to the propriety or impropriety of these actions, thus a man who has had a bad Education becomes awkward & has a particular carriage that uniformly accompanies him thro' the whole of life, but this is a matter more of curiosity than importance. By the Application of Stimuli to a part Sensations are renewed & any other sensations constantly associated with them will likewise be renewed. It is in this way I would explain why a Stimulus applied to a small portion of an Artery will excite the action of the contiguous parts, and why topical Inflammⁿ are excited from external Stimuli, and why active hemorrhages have been local and have not extended over

over the whole System. We can thus too explain why Stimuli applied to the accretions increase the action of Secretions, & the ordinary state of the peristaltic motion is associated with the action of every Secretory pouring out a fluid in those Cavities; from hence may be deduced likewise why all the Secretorys may have their several accretions increased by an increase of the peristaltic motion, & perhaps it is upon this footing that they act more on one part than another. The Organs of Respiration & the action of the Thorax are strictly associated together, but one of them may be under the influence of a Stimulus or under a Spasmodic affection, and then the degree of Contraction in the Diaphragm & abdominal muscles is limited, but the degree of motion in the one pretty generally corresponds with that of the other, for if the Muscles should be impeded in their functions the Bronchia or Air vessels in the lungs are so constricted that the Air has not so free a passage into them as usual. —

4. We come now to the 4th Law. — Custom determines the order of Succession in the Associated motions, the Velocity with which each is performed & with which they succeed one another. In this Paragraph I have been guilty of an Omission, I should have

have said that Custom determines the degree of force with which Actions are performed. All our muscles acquire more force by repeated exertions, & muscles that have not been exercised cannot be performed with a motion beyond the usual degree of their exertion, and Muscles that have been always exercised with a certain degree of force, cannot be exercised with less without debility or inaccuracy.

A Smith that has been constantly used to the motion of his hammer will find himself very incapable of handling a pen with any degree of steadiness tho' better perhaps on a Sunday than any other day wherein he is employed; how different is the business of a Watchmaker where steadiness & nicety are more required than great muscular exertion, and how incapable is the Blacksmith of so nice and delicate a business, he being always used to a certain degree of force cannot perform a less with any degree of accuracy. I should have observed in the paragraph that custom determines the order and series as well as the degree of force & velocity. Every body must be acquainted with facts applicable to this purpose, for in action as well as sensation the effects of interruption in the usual train of our Ideas are equally observable in confusing us & rendering them irregular.

Me

We yesterday considered the effects of habit & the several laws of Association. I mentioned the omission in my text & supplied it by saying that custom determines the degree of force with which any particular action is performed. I gave illustrations of this when I said a man that had been accustomed to exercise with a certain degree of force he cannot adapt himself to motions where small exertions are required constantly with steadiness and accuracy; from the effects of habit & exercise in giving force we can easily understand why our strength is limited to a certain degree, or why a greater force cannot be exerted by us on any occasion than we commonly exert, but the attention to the effects of exercise will lead to any easy solution of these phenomena. In voluntary actions the force depends entirely on the will, & on this account is a law affecting the exercise of our Volition. I shall give a familiar example of this; a Golf player can drive a ball to the distance of 100 yards pretty exactly, many people tho they can drive it further yet cannot measure that certain necessary degree of force that is requisite to the sending it so far & not farther. They will thus by repetition acquire a power of exerting various degrees of force; not one person in 100 perhaps

perhaps can acquire this power of limiting the various degrees of force but by repetition, for it is subject to certain habits & is subjected to the influence of volition only in consequence of it's being previously subjected to the laws of custom & habit, so that a man having frequently repeated a certain stroke it at length comes under the influence of the will, but if he has been used to drive it to a great distance he cannot drive it to a less distance & adapt his muscles to a smaller degree of exertion without unsteadiness & inaccuracy. Now it is to be observed that any attempt to measure certain degrees of force either greater or less than we have been accustomed to is always accompanied with great uncertainty; if I have been used to drive a ball 60 yards and try to do it 80 or 100 I cannot perform it steadily, the motion becomes convulsive & in some measure involuntary; if a man in a bowling green of a determined length has acquired a pretty exact habit of measuring his bowl, let him be carried to a green of a larger extent and he will find much less exactness in measuring his distance. This we shall find of extensive application as it serves to explain many of our actions. If a degree of force has been measured by habit & repetition
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we perform it with the necessary exactness, but if we attempt to exert a greater it is convulsive and involuntary & approaches to a degree of Spasm. This is not only confined to the Organs of voluntary motion, but even to those whose action depends on Stimuli & extension; if the excitement should be greater than usual the motion is convulsive & spasmodic; we shall find a further application of this hereafter. When we speak of custom determining the force & velocity of Actions, & determining the interval i.e. the time taken up between any series of Actions, This is analogous to what we observed before with respect to the effects of custom on Sensation that any attempt to change our usual order throws us into total confusion, there is likewise a distinct exercise of the Series of Actions, Musicians when pursuing a regular train of sounds if any thing stops them they cannot resume the train, they are entirely interrupted, or if they miss a note they are thrown into confusion & in order to catch the train again they must begin anew, this however is but of little consequence in the observation of the bodily functions.

Hurry is an attempt to perform actions with unusual velocity & then convulsive violent and
spasmodic

spasmodic motions are produced; this has a great connection with interrupting motions, & has a considerable share in the Phenomena of the system. This must particularly affect the operations of the intellect, these consist in a certain train and are from various causes subjected to the powers of habit, & any unusual force or velocity may have the effect of confusion.

The several Emotions we are liable to be affected by have a proper balance provided for them, & when matters go on in their usual trains the balance is equal & properly kept up. Anger is balanced by temerity, fear by its opposite, these are in consequence of the usual train in the operations of Intellect; when the causes of Intellect are not violent then Intellect commonly follows the operation of that passion, but when the causes of Emotions approach suddenly they hurry the train of our intellectual operations, & then it must interrupt the series & succession that should necessarily follow, the Equilibrium between the several Emotions being totally destroyed.

Fear & every sudden Emotion will produce irregular motions as Epilepsy &c. & these irregular motions must arise from the hurry produced in the

the intellectual functions, but this is a different kind of Mobility from that which we had occasion formerly to treat of, for it depends not on the particular conditions of the Nervous power itself, here merely irregular motions arise that produce others in which the mobility chiefly appears, & depends on an unusual velocity in the succession of ideas & actions; but tho' there is this difference yet there is a close connection with this & the case I mentioned of Mobility depending on debility, for most of the cases of hurried & irregular motions I have instanced depend ultimately on debility; firmness or presence of Mind is the guarding against any interruption of regularity or order, this is in proportion to the degree of vigour whether natural or acquired; some degree of vigour naturally in the system is obvious from the effects of all Impressions, but in all men there is great part of this vigour acquired by experience. The effects of surprise or any thing interrupting our usual train are most remarkable in persons of the greatest mobility. The systems of Women and children are much more Mobile than those of Men, and of consequence they are more liable
to

liable to be affected in a greater degree by those causes; it does not wholly depend on the natural irritability in the Systems of those persons, but on their mobility & want of Experience in the various occurrences of life taken together. While I say these motions are irregular from any Acceleration be in our Sensations & Actions I impute its effects to take place in consequence of debility which is a cause of Spasm. I need not add that this irregularity happens commonly in particular functions when the heart is thrown into violent motions; this arises from its hurried motion in interrupting the natural order of its motions.

5. The proofs of this proposition are obvious to every one. Few are unacquainted with the history of the Staffordshire Idiot, who used constantly to observe whenever the clock struck, & whenever the clock was out of repair so that it could not strike the hours, yet when the Impression was absent the connection was so strong by habit, that he numbered the hours as usual, and at the exact period that the clock should have struck the hour. In Infants we have many instances of such periodical motions returning at various intervals which have seemingly no evident connection with

with any thing that would excite them. Nothing is more seemingly inexplicable than the Animal Economy in this respect, but the mystery does not lie in the periodical return of such motions, but, is in reality the effects of custom establishing a certain order or succession of Ideas & actions & establishing that order with a determined measure & velocity. When we understand that custom establishes the order & succession of our Ideas & actions with a certain velocity it is obvious for us to admit a variety, & then it is easy for us to insert any thing in that series, & any one particular in that order will recur as well as any other. There are circumstances in the Economy,

The Economy is from its nature subject to alternate conditions & various vicissitudes. A state of Watching has a constant tendency to induce a state of Sleep, & Sleep has the effect of bringing certain dispositions to watch, & as we remain free from Stimuli it will induce Watching, here there is a considerable vicissitude that all animals are subject to, why do these vicissitudes occur at,

at certain intervals, why is their periodical return sometimes longer sometimes shorter, this we cannot attempt to explain but must be contented with the fact, that they are laws of the Economy that effect the determined return of these vicissitudes within 24 hours. The same Phenomena appear from other considerations of the Economy. We know the body to be full of fluids that are just suited in quantity & quality to the condition of the vessels, we know it pours out many of these fluids by secretion & excretion, now if there was not some supply to make up for this waste the body would soon be empty & this emptying is connected probably with a return of appetite, & the system is again filled. We might mention a great variety of instances that determine the Economy to certain vicissitudes, as the occurrence of many external circumstances, being exposed to light and darkness, heat, & cold &c, some of these are not obvious in their powers & operations, & upon that account their effects are not so much considered; but some have particular effects, & they all concur in producing effects, so that, altho' the powers of particulars should be but inconsiderable yet the general concurrence of them

them all become great; these daily vicissitudes must influence other causes, & establish a certain diurnal revolution in the system. We might find other causes giving the periodical return of certain motions between intervals; but if any circumstance should occasion a more than usual increase of these periodical returns, it wd in all probability diminish them the next day; from their taking place at different times there is no difficulty in admitting an analogy. When every action has a determined time of velocity & habit has a power of determining that time of velocity & both these concurring may give different periods if they happen to be inserted in the same series, these may determine the time & periodical succession of every action & thus we see that the mystery of exact periods is the effect of custom determining the order of succession in associated motions the velocity with which each is performed & with which they succeed one another; this is equally curious & important as it has effect in all the operations of the system & remarkable in diseases many of which are regulated by exact periodical returns. I shew you the foundation of explaining this which is of extensive application but I cannot here illustrate it

Dear Sir

One of these papers to be Boiled in five pints
of Water, to four pints, ^{and Scurting} afterwards strain it, and make
use of it in one Day, taking the powder at same
time as formerly.
then Decant, and Scurt it to taste, and make use
of it, as ^{your} common Drink, taking the powder as formerly.

it & apply it to particulars, it would lead us into too large a field & so general an application as this would admit of would not be incompatible with our limited time, but would likewise interfere with the prosecution of those other subjects which are absolutely necessary for us to treat of.

Most of the laws I have mentioned determine the actions & return of sensations, where the brain is concerned but not independantly of this organ. I have now proved my proposition but I want to say something further to make it clear, I speak of the Vicissitudes of excretion & appetite which are performed in a certain measure of time. It is possible a change in any of these may be periodical, but most regular periods are such as depend upon the brain & on that only even those that depend on the operation or are connected with the operations of the sanguiferous system, depend ultimately on the brain, & the periodical motions of the alimentary canal do not so much depend on the emptiness or fullness of the canal, but on the recurrence of certain sensations in the brain; an instance of this is seen in people whose usual hour of dining is at a fixed time, & the return of appetite is confined to that period. A man that has been accustomed constantly to dine at 3 o'clock the
Sensation

Sensation of hunger will Recurr to him pretty nearly at that time, and this is not so much from a state of emptiness in the Stomach as from a recurrence of a Sensation that custom had always determined to arise at that hour; that this is the case is evident from this circumstance that altho' the Man has omitted taking his breakfast in the morning, yet he shall not be affected with the Sensation till the usual period, which if it had alone proceeded from a state of emptiness he should have been affected in all the intermediate time between breakfast & dinner, there is some difficulty in explaining the emptiness & fullness in different parts of the System; appetites will return periodically even tho' a man does not eat at his usual period his appetite will pass away, & he will have no recurrence of hunger till the stated period returns, this depends on certain laws depending on the brain & its peculiar operations; we have many other examples of the same kind with regard to excretion. Many people are accustomed to go to stool at a certain stated period, the Stimulus to evacuate the feculent matter returning readily at a certain time, if there is a greater quantity of faeces in the rectum than usual, or if there is less there is no recurrence

recurrence of the Stimulus in the Interval between the stated period, neither is there any omission of the return of the Stimulus at the usual time. The inclination is determined by habit to return even when the Stimulus is to appearance weaker, if likewise the Stimulus sh^d pass away upon the Evacuation not being performed, even then it will not return in any intermediate time but at the periodical stated time. It appears that the state of the functions is correspondent to a certain measure of time, this may have an effect in determining to certain periodical revolutions, but there are some circumstances in the Nervous System that render it capable of submitting to such laws.

In concluding this subject I would give some important applications of habit, but this wd interfere with other subjects wch I now proceed to treat of. I have been speaking of habit either single or connected. I shall now go farther into the subject, & enquire how they come to be performed at all & what it is that performs them. This is a difficult but an investigation absolutely necessary & of the utmost importance in our pathology.

After having determined the effects of Customs we now proceed to enquire into the causes of particular

particular actions. This question is of great importance & is of much more difficult solution than some have imagined who have contented themselves with answering it in very general terms. I shall make some attempts towards an explanation of it tho' I despair of doing it satisfactorily.

CXVII. I say the action of the Brain is determined to particular muscles or moving fibres by the following causes.

1. I grant that most of the Actions in our system arise from motions first begun in the brain, that our ordinary actions depend on the constant energy of the brain influencing those particular actions, & no unusual force can be exerted by us without the particular intervention of the Brain. The causes that determine the action of the Brain to particular Muscles are - 1st Stimuli applied to certain parts tho' producing no Sensation. Stimuli or causes of increased motion produce an action of the Muscular fibre without any Sensation. I have before proved that Impressions produce Actions without any Sensation in consequence of the peculiar structure or organization of the Muscular fibre which may be excited without the intervention of Volition by a direct application made to the Muscular

Muscular fibre itself. A motion is communicated from the place of Impression which produces a Contraction in the fibre dependent on its peculiar Structure, but a Contraction can be excited by the application of the Impression to a part at some distance & not immediately to the Muscular fibre itself; it is well known indeed that contractions are excited by applications made on sensible Membranes, but it is uncertain however how far this may or may not be a direct application. I gave an instance of this before in the case of purgatives, I confess indeed that the application of this instance is not quite clear, for as the action of a purgative consists of certain volatile parts, that we suppose reach the Muscular fibre because when applied externally they excite its contraction, but this state of direct application to muscular fibre cannot be supposed, because a direct action succeeds when the place where the Impression is made is at a considerable distance, so that the motion produced must be communicated to the Muscle, which Communication can only be performed in consequence of the intervention of the Brain, therefore the Action of the moving fibres arises from motions first

first began in that organ and from thence communicated along the Nerves to the Muscles, tho' frequently without any Sensation produced; it has been supposed that motions may be produced without the intervention of the Brain, by a local connection of nerves to which they have given the name of Sympathy, but this we shall examine hereafter.

2. We come now to the 2^d part of our Proposition, viz, by the condition of certain parts producing no Sensation, but by a condition analogous or like to that w^{ch} produces a Sensation of Consciousness. If we suppose a Mechanical condition of the Brain may be such as to produce action without a Sensation of Consciousness, it will lead us to a Solution of this problem; that there are such conditions I before sufficiently proved and these conditions are in consequence of diminished motion or of Collapse; the contrary is an Excitement, this sort of Communication is often from our increase of Motion & this increases the difference between sensation Sensation in a part, & the motions they produce in a very different one.

3. Motions of the Brain are determined to moving
Fibres

fibres by a sense of pain or uneasiness arising from certain parts; it is rare that sensations producing neither pleasure nor pain produce actions, it is universally true that every sensation is accompanied with one of these, and these are attended with propensities to avoid the evil & conciliate the Good; perhaps you may think I should have referred this effect to the after article of Propensity, but Propensities strictly so called are where they specify a determined motion produced, & this I distinguish from Pain & Pleasure in general, which produce motions exactly similar to the sensations

4. The cases I have mentioned may arise from topical conditions of the Brain, & these are supposed to be causes of particular determination of Willing &c in our internal actions. But this is considered in too limited a view, we don't consider the circumstances of any action produced as acting only by a general operation on the Brain, but it must particularly be observed that they don't arise from causes depending on the circumstances of particular parts, for these don't give the series of motions that arise here
but

but they depend on causes arising in the Brain and partially communicated from thence to particular parts—hence the Mobility of certain parts much greater than others, and it will be obvious that as general affecting cause of the System sh^d under a general excitement affect particular parts only. Those parts of the body that have lost their Tension are moved on the slightest occasions, Paralytic people who have lost their tonic power are generally very weak & mobile, and every motion of the Mind will induce a tremor in the parts affected more than in the rest of the System. My Stomach is often much affected by thinking, but it has been weak previously & very mobile else there wd not have been such a partial determination from the brain to that Organ more than to some other parts of the System. Numerous instances likewise occur of the determination of general causes to mobile parts.

5. By a determination rendered more constant by Stimuli or habit.

Perhaps this might have been included under the former title, but some cases that I shall mention here may be consistent with the usual vigour of the System, the former on the contrary are owing to debility.

It is certain that this constant determination by Stimulus establishes a habit in the vital & natural functions that continue their motions while the action of the Brain is suspended, as in the cases of Sleep. But there are many morbid motions arising from particular causes that are rendered habitual by repetition & can be renewed without the repetition of the original cause that produced them. I take only a simple example to illustrate this; Squinting which proceeds from a peculiar direction of the Eyes & is confirmed by habit, but in persons where it has arisen from particular causes it only appears on particular occasions, & every motion of the Mind has the effect of inducing Squinting, which at first was a determination established with respect to particular muscles.

Stammering is likewise an affection of these organs that is brought on by every Emotion of the Mind; The heart is another instance, it is often exposed to violent palpitations, & by repetition becomes palpitated, by every emotion of the Mind; thus we see that the various irregular motions that take place in different parts of the several functions may arise from general causes; Epilepsy is a more remarkable instance which is first induced by fear
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and Anger, but by repetition it becomes affected by every unusual state of the Mind or body, & we can only explain in this way why the same emotion of the Mind should in one person produce Hysteria, in another Epilepsy. So far we have proceeded in assigning the causes of determination to the Brain from motions first begun in certain parts producing sensations of consciousness.

C. We now proceed to consider the causes operating only on the Brain, but by that producing particular actions — 1. By Imitation. The effects of this are well known. Aristotles called Man *ζωον μιμητικόν*, an Imitative Animal. Of the Objects of our Imitation are chiefly ^{those of} motion, tho' sometimes even inanimate matter, but especially the motions of Animals of the human species, & particularly those attendant on the passions of the Mind. Our faculty of Observation proceeds from the Rays of light falling on the bottom of the Eye, in consequence of which an inverted Portrait of the Object from whence the rays proceeded is produced; but how motions produces sensations in the Brain & stimulates that organ to produce similar motions is difficult to explain.

It is impossible to shew the manner of Mechanical Connection; we are indeed disposed to imitate the motions

motions of the body & produce in ourselves actions similar to these, but the rise of the passions in the Mind do not depend on external Impression, not on the picture drawn in the bottom of the eye, for any particular passions and agitations in the features of the face would have no effect in us in producing the particular passion of a person's mind, they would only in us produce a general emotion tho' perhaps totally different from that which affected the person before us. That peculiar expression in the face is but a means of producing the original passion that caused it, it is not a communication of the internal feeling or sentiment, but is only attended in the person acted on with extraordinary motions imitative merely with respect to features, to that temporary action of the Muscles of the face of the sufferers, produced however in a different manner than from Impression. A Man from an unusual taste in a substance unknown to him, from the experience of a strong impression will conclude he has got a poison, & is immediately apprehensive, but a stander by will tell him there is not the least danger for he can taste the substance 100 times without apprehension of the consequences— in this

This case we receive the motions of the mind from different senses.

It is not however the Impression even by the means of any sense that is productive of the imitative effects, for this serves no other purpose than as the medium by which the passion is communicated; it is only the internal energy of the mind that produces Imitation, it is the volition that determines us to mimetic representation of any particular object. This connection of Imitation is established by the consideration of the whole phenomena that occur. A song has the effect of determining a person with a good ear to imitate it; this depends entirely on the goodness of the ear, for we cannot immediately imitate it, we are not in a condition to accomplish this without establishing the Idea in our memory, and the imitation is merely produced from the sensation not from the Impression. Upon the whole then our conclusions will amount to this that it is not from the connection of the Impression nor from a local connection of Nerves from particular Sympathy is the motion produced, neither is it from any reflex ideas, but it is wholly in consequence of volition excited or a modification of Impressions in the brain determining

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to the Volition of such particular Actions. I now go on to consider

7. Propensity. I have been pretty full on this subject before, & considered it as arising from Pain or Pleasure suited to remove the one and conciliate the other. — They have been supposed analogous to the state of Stimuli as acting by a local connection of Nerves, but this is improbable, from the consideration of uneasy impressions being made on the same Nerve, in one part, produce no effect in another part of which this nerve is a continuation; thus cutting the rectum or bladder will not excite the action of the Diaphragm & the several Muscles concerned in excretion. — A Man in the exclusion of faces has his Diaphragm and Abdominal Muscles exerted, & in order to restrain respiration he grins with his mouth and uses various contortions, which motions are not naturally constant but are considerably varied in different people, & we must consider them not as peculiar to the Impression but to the degree of Effort or Exertion produced; they therefore are only connected with the effort, and even with this they have no necessary connection. I before observed that the Will was not always uniform
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in producing motions, nor does it always produce motions the best adapted for the particular purposes required. The actions arising from Propensity do not proceed from the motions of Impression on the part where the Impression was made, but depend on particular propensities excited in the mind determining to Volition.

8. The last cause of the Determination of the Action of the Brain is by Will. We say when any Action arises with a desire of executing that it depends on the Will—here the powers of the Soul appear, & the willing an Action to the performance of an end is what we call Intelligence distinguished from propensity appetite &c. We know that many actions are produced from Volition that the Mind is conscious of directs to particular purposes, but the Stahlins imagined that all the Motions of the body were dependant on the Will, & that the Mind had intelligence of & directed every motion of the Economy; but this is not to be admitted, for if we allow these principles their System is founded upon to be just we must entirely give up all further Investigation, as their doctrine entirely supercedes all our reasonings in Physic. I therefore reject it

it, and assert on the subject of Will that no proof of Intelligence arises in governing the motions of the body. The Mind for instance is not conscious of willing the action of any particular muscle, all that we can observe is the willing of certain motions that are somehow connected with the motions of particular muscles, which are connected with all the cases of Sensation & Propensity. The end is often obtained by a combination of different parts of the body which we are not in the least conscious of willing. A person learning to write does it by a gross imitation, he does not consider the particular means in order to effect this; the manner in which he rests his elbow & how he restrains the motions of his body, these are not at all the objects of his attention, he conceives nothing further in his mind than the end to be produced, not in the least conscious of willing the particular performance. In this case nothing appears like Volition applied to the administration of motion—neither in the expression of any particular passion we neither will many of those contortions of countenance nor are conscious of the ridiculous effects they produce.

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In propensity there is still a more explicit Volition with regard to action, but it is very often without designing any particular action, or I say if we are in certain propensities conscious of designing certain actions it is not in the first instance, but always only in consequence of experience. In what we more strictly call Will there is this farther that the action is foreseen; it is especially in Volition that there is a will of gaining a certain end, but it would appear from what has been said that the Willing an end is without any consciousness of the particular means, and the connections between willing a particular end & the several actions for obtaining this is as much an arbitrary connection as in the other two states of Propensity & passion.

Tho' we have been very forward & seemingly very pointed in distinguishing voluntary & involuntary Actions, I maintain that the distinction is made with no accuracy or certainty as to what Muscles are under the power of the Will or what not. Properly speaking no particular Muscles are under the power of the Will, but only as they have connections with motions, that are under the power of the Will. These are chiefly the external motions, the internal we suppose

suppose are out of the reach of it; but there are none of the external actions that are performed by the single action of a separate muscle. Now so many Muscles thus combined are said to be under the power of the Will—take notice what limits this admits of; hardly any. In particular actions a few Muscles only are employed, when we make the action more general more are brought into contraction, & the number of Muscles employed seems to depend on the degree of effort designed, for when that is considerable every Muscle in the body seems to have a share in giving fixed points, & a tension to the whole Muscular System—this extends the power of the Will over a prodigious number, and if it at the same time appears that the action of the heart is increased in this general exertion, then I say it is as much as the rest under the influence of the Will—its particular action is not the subject of volition, but this is precisely the case with every other Muscle. In short in order to determine what are voluntary muscles the question is whether or not it can concur in the execution of an action or the obtaining the end that is willed. Now I would alledge that in every great effort
expressed

expressed with great earnestness the action of the heart is increased with that of others, & therefore that it is in some respect a voluntary muscle. The famous case of Colonel Townshend gives me no difficulty in the explanation - he could for a time make the action of his heart cease & again renew it. If the heart is affected by every effort its action will remit upon the ceasing of that effort; & will be again renewed on resuming the effort; we shall have a particular application for this immediately.

With regard to the operation in the Brain - I say when we consider from how many different & various impressions, the same volition may take its rise. No body will here suppose there is any connection between the Impression and Action; therefore it is undoubted that in this case the connection is merely between the volition & Action, between a certain state of the brain and the Action produced, I have shewn that such is also the case in propensity and imitation, and I have endeavoured to render it probable that in all cases where Sensation of any kind takes place & produces action, there is more
or

or loss of general propensity & therefore a like connection of action with the state of the brain and not with the Impression that first gave rise to it. To illustrate this there are many cases where at first sensation does take place, but afterwards by habit & repetition we lose all consciousness of it; but tho' consciousness is lost there is little doubt but the same condition of the brain still continues to take place & therefore there is proper room for the Analogy.

That Actions produced without any consciousness of sensation & Volition may have something analogous that connects them together. All this is meant particularly to destroy the notion of particular Sympathy, of which more hereafter, I shall conclude this paragraph with two Corollaries.

Corol. I. That the whole train of our present reasoning in considering the 3 last causes of particular determination to the brain shews that it depends on Sensation rather than Impression, & it's so much depending on Impression affords me the strongest Argument of any for the existence of a sentient principle in our System. Dr. Whist has been very well employed in establishing this doctrine, but I think he has given up the strongest part of his Argument by admitting any motions purely

purely involuntary - I am very fond to add that while many Metaphysicians have so often endeavored to make Thinking the essence of the Soul & inseparable from the immaterial principle, I think it is inseparable from the whole of the corporeal motions that take place in the animal Economy.

The general proof of a sentient & immaterial principle in us is I think extremely well supported, but its application to Physics requires much caution & discretion; let us avoid the abuse and maintain the general truth.

Corol. II. While so much depends on Sensation suppose we should also add that this is connected with a particular state of the brain, as many Arguments may be brought to prove. But this state of the brain depends on a peculiarity of Organization any part of which we have no perception of. In short the connection this may have with different actions of the body are as little discoverable as if they consisted in the operation of an immaterial principle, & the whole I am afraid is reduced to an insoluble problem. We must be contented chiefly in marking facts from whence we may possibly find more general ones, & more general laws of considerable use in our System

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of Physic. I shall now just say that our present subject is incomplete. There are cases of particular determinations to certain motions that, we have not here touched, I mean those that are not so much to particular motions as to particular functions. I sketched that in fact these determinations take place. Some poisons act chiefly on the natural functions, others upon the vital in bringing on Syncope, others operate upon what are more strictly called the Organs of voluntary motion; the causes of these particular determinations are extremely difficult; they may be sometimes a part of the motion depending on the Will, Propensity, Imitation, Stimuli applied, or conditions existing in particular organs, concerned in these several functions. — But there are other cases where they manifestly depend on a particular relation of the Brain to these sets of functions, & this must be explained in order to complete our present paragraph. — What I know of the subject I have said before and will not now resume it.

CXVIII. I thought it was necessary to say here expressly that the Phenomena of many parts of the System depend on the cessation or diminution
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of the Action of the Brain, which every one knows, as in the case of Ligatures on the Nerves, & Hemorrhages bringing on Syncope, by weakening the action of the Brain, but few have observed that when action appears it may be owing to the same cause. We are apt to look only for stimuli or other causes of direct determination, & scarcely think it may be owing to withdrawing the action of the brain. When the action of the Stomach is excited in Vomiting we consider it as, ^{owing to} a stimulus applied to it, or the neighbouring parts connected with it, but we find that it often depends on the withdrawing the action of the brain - as when it occurs in Vertigo, the various causes of Syncope, Narcotic poisons applied to the brain; and this is another proof that the causes of Collapse are often causes of action. The various causes of Collapse ought therefore to be studied, more particularly to discover how the determination is made to particular parts, & some more than others, which is to be discovered chiefly by the causes of determination mentioned in the last paragraph - With regard to the 3 first heads of causes, a part will lose the determination of the Brain by losing any

any usual Stimulus or causes of it's tone or tension whether with or without Sensation.

With respect to the 3^d & 4th causes they may be causes of more considerable Diminution of the action of the Brain with regard to particular parts. The same part that has acquired mobility by debility will feel every general cause of the diminution of the action of the Brain. Every part supported by more accustomed Determination, if at any time this is withdrawn, such parts *ceteris paribus* will sooner feel the diminished action of the Brain than other parts not exposed to any such constant habit. These causes are therefore the same in one state as the other, & only according to the state of the brain produce different effects.

It is obvious with regard to the 3 last causes Imitation, Propensity, & Will, that the motions depending upon any mode of Volition will cease when that Volition ceases. I will only say that there is even somewhat Voluntary in withdrawing & suspending the will. There is, if I may say so, somewhat active in the withdrawing of actions, that is to say that causes operate when the causes of Determination still

still continues to act. It is a question but not with me whether or not the Will relaxes as well as contracts Muscles. Mr. Winslow has given an example which to me is decisive. When I take hold of any fixed point about me I can by the muscles pull up the weight of my body, & when I let down my body again it does not appear by any phenomenon to be by the action of the Antagonist Muscles but by a gradual remission of the same contraction.

We have further to add that there are peculiar causes of the withdrawing the Action of the brain from particular parts, as first the action of Sedatives that weaken the action of the Brain, & these are particular circumstances that cause one set of functions to be affected more than others. The others are ligatures, compression, & other causes of interruption. These are also often more generally with regard to the brain, & sometimes affect our Motory Nerves alone, sometimes the Nerves of Sense also.

CXIX If we consider the numerous particulars that have been adduced on this subject it will appear a very large & extensive field of enquiry, but

but I think it is not necessary for us to enter into a particular detail. I will only aim at the general principles, and thereby lay a proper foundation of knowledge.

We observe every day affections & motions communicated from one part of the body to another considerably distant, with regard however to the means of such communication we have perhaps no clear or distinct notion, but in general we can observe the continuity of the Nervous System, & perceive that that gives the opportunity for such communication, and we can with regard to particular Nerves very easily conceive why a motion should be communicated from the origin to the extremities or vice versa. But when we perceive that the communication can only be made by motions passing from one Nerve to another, by the intervention of the Brain, there the difficulty arises to trace the course of the Communication, to find where it is that the several Nerves that form the Communication are any where contiguous, or in such a situation as to communicate motions equally — this in very few cases clearly appears. — On

In short I think Physiologists have ceased to attempt to trace the particular communication, and it is become very universal to hide our ignorance of this subject by employing the general term Sympathy. But when we thus talk & think we have in this manner assigned a cause. We are certainly wrong in Philosophy referring to an occult quality as a cause which present Philosophers have universally agreed in rejecting. If it be said that they only mean a term for a general fact, it is allowable, but if we use such a term it must be always taken in that we consider it merely as a term & acknowledge that it truly expresseth nothing. When a stone in the Urethra excites vomiting, nothing is more common than to say it is owing to Sympathy, which is really no more than to say that such a fact exists.

However we know from Experience that the employing general terms is liable to much inconvenience. It is extremely difficult to prevent the notion of a cause creeping in upon us, and generally with this bad effect that we remain satisfied and it supercedes all further enquiry.

I must however allow that there are some who consider it as a cause that do not mean thereby

thereby an occult quality as they have attempted to assign the nature of their cause, & they may be allowed to make this step as they say it is a communication between the parts of the Nervous System, which we know are all more or less contiguous, & they indeed limit the term to this.

There are several communications in different parts of the System that do manifestly depend upon the communications of the Hydraulic System, but these are few in comparison to the many where we find no change in the Vascular System, and it is agreed that the most frequent instances of such communication, even where the Hydraulic System is concerned are however primarily taking place in the Nervous System.

Some Physiologists proceed a step further & say it is from a particular communication between certain parts of the System more than others, which determines the communication of motion to be constantly in that way & no other, & they suppose it to be in that way with I call a local connection. Now it is this particular explanation of Sympathy that I must consider. The local connection

connection is supposed in some cases to be only in the Brain or common Origin. In other cases it is supposed to depend on such local connection in the course of the nerves.

1. With regard to the local connection supposed between the origin of different powers in the brain, I refuse there is any such thing distinctly perceived, & no foundation for the supposition in most cases of communication. My argument is this that in almost all the cases of communication a sensation takes place, & therefore there is in general a particular propensity or will taking place at the same time. If there are any exceptions I have mentioned an analogy that will apply to them. Now in considering all these as cases of particular Determination I have I think proved that there is no connection between the Impression & action, as there would be if it depended on a local connection of nerves, but universally it depends upon an impression producing a state of the brain that is more general with which the action in particular parts is expressly connected. Dr. Whytt quotes Hippocrates who says that the Sight of a serpent produces a paleness of the face, but I say there

There is no particular connection between the image of the serpent in the bottom of the eye & the motions of the vessels of the face; but the sight of the serpent produces the idea of danger which gives occasion to the paleness of the face. This we know from this circumstance that it is in very few people that the sight of a dead serpent will produce a paleness of the face, and from the same effects being often produced from very different impressions, & from different senses; thus the noise of a rattlesnake to those that know it will have the above effect; there is no matter from what Image the passion or emotion of the mind arises, it will equally produce the paleness of the countenance, & therefore I wd conclude there is no necessity or probability in the supposition that it depends upon any local connection between the vessels of the eye, ear, &c. and those of the face.

Sympathy has been divided by Authors into general and particular.

It is particular Sympathy when we refer it to such local communication, it is that only I argue against.

(The

The other is general Sympathy in which every motion of the body is connected with the Brain and in consequence of that any part may be affected by all the general states & conditions of this Organ. Joined to the formentioned causes of particular determination I venture to say that a very little attention to the particulars enumerated under the title of Sympathy will shew that most of the instances are of this kind.

Authors have reduced the instances of Sympathy to different heads. Some they suppose depend upon the communication I speak of, and these they say are Jure officii.

In others where they cannot condescend upon any particular affection they say they are Jure officii or motions connected together & combined in the same function. When a quantity of faeces weigh down & irritate the rectum, the Diaphragm & abdominal muscles are joined in their action Jure officii, they say from a local connection of the nerves of the rectum and those of the muscles.

But there is no reason for this; they are only united in the same propensity as all such motions are that are united jure officii, for if the evacuation

tion of the rectum requires a stronger effort, all the Muscles of the body may be brought into action, & therefore can be no other but the general Sympathy I speak of. From the consideration therefore that actions are united with Will & Propensity there is no need to have recourse to any particular Sympathy. But I say there is no such communication between the Nerves that seem to operate upon one another in the common Origin as has been supposed.

I say it is not in general possible, for many of the instances of Sympathy depend upon the Association of Ideas, and it is very well known that this association may be formed in the most arbitrary manner between any impression and any action; from this it is plain that if any motion excited the other by any continuity of Nerves, then every Nerve in the body must touch every other Nerve immediately, so as to admit of a direct communication from the one to the other, and therefore every impression should excite every other Impression & every motion universally, which is manifestly absurd.

But it may be alledged that in one part or another

another every Nerve is contiguous to & touches every other, but this does not give occasion for every Nerve to move every other; the only circumstance that allows this is their Synchronism or their having been struck nearly at the same times; now we do not perceive the Sympathy to take place on any other condition, and I say that mere Synchronism under great variety of relations is enough to establish the Association, & for ever after the mutual excitement of one another.

But there is still perhaps another suggestion. It may be said that Synchronism establishes Association, but without Synchronism or with much less repetition of it the marking of relations between Ideas & Impressions does establish the Association. It is true, but this shews that it does not depend upon any connection between the Impression and motion produced but entirely upon the relation, for it is certain that in any complex object it is very possible that of every one of ten lookers on every one shall mark a different relation tho' the impression is made equally on all the ten but has no effect on Association unless the relation be marked. It is therefore true that the relation following such association is connected

connected with a general state of the Brain.

There is another consideration. Since the Nerves came to be more accurately dissected we can perceive that there are certain Nerves that have a very general connection as particularly the 8th pair, the intercostals &c. & accordingly they have been much employed to explain particular Sympathies. But the communications of motion depending on this so considerable connection of Nerves are in fact very few. If the connection of the several Branches of the 8th pair was to determine the communications of Motion I say we should have 20 instances of particularly Sympathy for one we truly observe. This is more evident if we consider that the communications of affections between the several Viscera are often owing to communications, in the Hydraulic System, & tho' there is really a communication properly Nervous yet we have innumerable instances of each of the Viscera separately affected. It is true when the Kidneys are affected the Stomach is so likewise, but if it was merely from a communication of the Nerves the whole other Viscera should also suffer; but we have many instances of the Kidneys being

affected without any other of the viscera. If an Inflammation in the liver is attended with a pain in the right shoulder we think it enough that the shoulder has a branch from the 8th pair, but there are 50 other parts that have branches as well as this without any such communication happening. Nothing is more obvious than that if this communication of nerves have any effect at all it must have effects in 20 instances where it has none, and there upon the whole with regard to the first means of communication that subsists between different Nerves in their common Origin I say the supposition of effects from such communication are altogether improbable.

2. With regard to the other Supposition, most Physicians have entirely given it up. It is now agreed that every single fibre of the Nerves proceeds distinct from their origin to their several extremities without any such communication of substance as can account for the frequent communications of Motion. The same Nerve has, its branches distributed some to Muscles some to Sensitive parts, which are sometimes nearer, sometimes

sometimes farther off, & we receive Impressions very often from a small part of the body, which if it were liable to communicate Motion to the other fibrils adjoining we should no longer have any distinct Sensation from particular Impressions. We may add that the fibres are every where in their course more or less separated from one another by a matter or membrane probably of a different nature from the medullary substance. Many other Arguments are now brought to the same purpose. In the prodigious number of Experiments Dr. Haller has made he says positively he has never seen any instance of a Communication of motion to branches going off above the place of puncture or compression - the whole of the Physiologists are therefore ready to give up this explanation of Sympathy.

I think this conclusion is very probable but I receive it with some doubt, I suspect they have pushed it too far, I think however the conclusion will go this far, that with regard to ordinary Impressions those made on the extremities of the Nerves will only have the effect to communicate motions along the fibres affected to the

the brain, and will not communicate them to others tho' tied up in the same fasciculus; but there are several instances of Communication of motion that take place between parts near to each other & which have their Nerves from a common Origin, as between the Ears & Teeth. When a shrill sound gives a particular Sensation to the teeth it is not certainly possible to say but that Communication is made with the Intervention of the Brain, but when we see it affect particular parts having Nerves from a common Origin, & that the communication is mutual & that it takes place in many instances where there is no sensation ^{such} however alone is not conclusive; from all this we have a presumption that there is some lateral communication between the nerves that are joined in the same common trunk, and I may say that tho' the common & ordinary Impressions have not, yet stronger Impressions may produce such effects. But what I just now mentioned from Dr Haller renders the Theory doubtful.

There is another ^{which} I am more disposed to believe, but offer it as a conjecture only. There
is

is some what even in the soft part of Animal bodies wh renders them more susceptible of tremors, & the communication of tremors than such other soft inanimate substances - of this there are a thousand proofs - In many of the most remarkable instances of tremors it cannot be communicated to the Bones wh are seemingly more fit for vibrations but thro' the soft parts in the first place. It is not always such a stroke as would occasion a communication from the Ulna or Cubitus to the Humerus. It is very often from Impulses of no great force but velocity. The Muscles of a Torpedo are perfectly lax & a soft pulpy substance, & the vibrations produced do not depend upon the force but the prodigious velocity of their motions - this probably will be referred to Nerves which are in every part of the body and in a condition to oscillate from the smallest motion communicated. In the case of communication from the teeth to the ears it is especially formed by the application of tremulous bodies to the teeth, & the whole communication may be formed thro' the bones to the Auditory Nerve - so in return we can sup-
pose

pose the tremor excited in the Auditory nerve
can be communicated thro' the same bony
Compages to the teeth. These are instances of
what may be called particular Sympathy, but
in these & the following cases it is not the commu-
-nication of the Nerves alone, but it is rather
their extremities that are expanded over the
same continuous membrane, & therefore it is
along continuous membranes that we especi-
-ally observe these communications take place;
thus I can allow that without any Sensation a
Stimulus in the Meatus Auditorius may be
communicated by the Eustachian tube to the fauces
& give a Sensation that will be a cause of cough,
and I have given reasons why these motions
will be felt in certain parts, as where the
Nerves are particularly sensible, or where the
motion is stopt in it's progress. In this way I
can suppose that the Oscillation of Worms in
the intestines may cause a communication not
felt but at the point of the nose, & that the irri-
-tation of a stone in the bladder shall not be felt
but at the extremity of the penis.

(With regard to the explication of the Pheno-
-mena

mena of the Nervous System the chief that occur are relative to the communication of motions from one part to another. When Impressions are made on any particular part & from thence communicated to the Brain, & observing a simple chord going from the part to that Organ, I then have no doubt of the mode of communication & I conceive the motions to be propagated along a contiguous & continuous substance. But in many cases where we cannot discover the line of communication, & we see motions are determined from the part to the Brain, & from the Brain back again to the part we cannot discover the intervention of any propagating medium. Then How are the motions communicated? We have hitherto been satisfied with an arbitrary connection because we cannot trace any between the parts & have applied the term Sympathy to this, but this is saying nothing & does not in the least contribute to the explication of the Phenomena. This opinion we have exploded as likewise the notion of an universal connection between every part of the body, if which was true no Organ could be separately affected. I observed
where

where there is a communication of any painful Impression we observe the pain propagated along the parts to a sensible portion, and wherever we can suppose Oscillatory motions propagated along Elastic Substances, where there is a stop there must be an Accumulation of the Oscillatory motions, & there pain is produced by the accumulation only when meeting with such interruptions.

With regard to Sensations produced without the intervention of the Brain some of these seem to shew a communication with the Medullary origin by Nerves in that Origin; thus there is a particular communication between the lower extremities & the Alimentary Canal. A person by setting his feet upon cold marble shall be instantly seized with gripes & perhaps Diarrhoea. Here there is a suspicion that the communication may be owing to a connection short of the Encephalon only by means of the Medulla Spinalis. If there are any communications of motion that lead to a suspicion of a local connection of Nerves it is with regard to the Phenomena that seem to depend on the Medulla Spinalis - but we must

must not either very certainly conclude this as these communications may have a great dependance on the Hydraulic System. A Constriction produced in the branches of the Aorta descendens in the feet may be propagated upwards & affect all the branches of the Aorta ascendens. This is confirmed by the effect not being confined alone to the intestinal Canal as being a more sensible part, but the Kidneys are often affected by it at the same time, occasioning a great flow of Urine.

It is obvious that we are here touching the fundamental laws of the Nervous System which must be extremely difficult (even in the attempt to set points in a clearer view) till that subject is more thoroughly elucidated. I am unable nor shall I attempt a thorough explanation of it, I shall throw out some useful conjectures in order to put you into a proper train of Investigation.

Here then I finish the Nervous System, & I expect that you will observe I have followed the plan I formerly proposed—to be more intent in finding out what truly happens than in explaining

-plaining how it happens, - in a word - to
ascertain facts rather than investigate causes.
I have avoided Theory, have refuted Doctrines
of pernicious tendency, and have seldom of-
-fered opinions of my own. I have made lit-
tle mention of Aether of which Gaubius says
in (parag. 524) speaking of it as a fact in
the nervous system - nec refert, utrum a
spiritu, quem vocant animali, per nervos
diffuso eandem repetas, an quoque alio modo
ab ortu, putes inditam, mecumve in re obscura
opiniendo nihil augureris. I concur with Gau-
-bius in saying that it relates to establishing
a fact very curious & singular.

Every Physiologist has proceeded farther
than I have done in explaining the Phenome-
-na of the Nervous System. You may pro-
-bably expect a further prosecution of this
subject from me, but I have previously de-
-clared my intention of acquainting you
merely with what Physiologists have ~~made~~
attempted on this subject, in order to secure
you from being imposed upon by Theorists.

I only think it necessary to enter on Theory where we can proceed to certain lengths, to usefull applications. Speculations however curious that have not this principal object in view I reject as inapplicable, and by this alone I form the proper Criterion of their Utility.

Before I enter upon the Theory of the Nervous System I beg leave to make some Criticisms on what has lately appeared in a performance termed the Encyclopedia Britannica under the Article Olfact, as some of my fundamental doctrines are there attempted to be ridiculed.

I should decline taking notice of such a catch-penny performance, or of an Author who is ignorant of the principles of the subject he attempts to ridicule, but that I am persuaded this Article is not the joint efforts of the Authors of that work, it is rather the suggestion of some malicious enemy, whom if he holds a rank in the literary world above that of a common Dictionary-writer I challenge to appear in public.

As several likewise whom I have a great regard for may join in the ridicule from want of knowledge of the principles on which my Hypothesis are founded, And above all such an at-

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lack may estrange the affections of Students from a subject ^{which} is of such considerable importance, I thought proper to convict the Authors of the Encyclopedia of Ignorance and Malice, but I believe their Malice reaches farther than their Ignorance.

How injurious are they to a person of the first rank in Philosophy, the immortal Sir Isaac Newton! They have asserted that the opinion of that great man is at present exploded one, that Philosophers consider it as the fable of his Age; nay farther that it is a mere reverie, a romantic Chimera.

But this opinion was long before maintained by Leibnitz, Wasse & all the Cartesians, & is still subsisting among the followers of Descartes in France to this day; it is by this doctrine of an universal pervading Ether that they account for their Plenum in opposition to the notions of a vacuum adopted by other Philosophers. Mr Euler takes the existence of an Ether as an indisputable point, & says Ether is diffused thro' every particle of matter in the universe. Another
Author—

Author de Lucis & Coloribus says Light is only
the vibration of our Elastic fluid - lumen per
medium elasticum totum mundum impleat
vatisimum spatium materie subtili impleat,
ut sonus implet medium - ut Philosophi no-
minant Aetherum; fluidum Aethereum subtilis-
simum, elasticum - Aether ut aer gravitate
prædita profundissima Natura Arcana expli-
care queat. When Sir Isaac Newton says that
the rays of light are not refracted from solid
bodies, he says there is an elastic fluid filling
up their pores on which the rays impinge. I
shall quote another author famous in the literary
world, Dr. Franklin (Letter to Cadwallader Colden
at York) who says, I am not satisfied with the
common doctrine of light being vibrated from
the Sun - may not all the phenomena of light
be solved by supposing all space filled with an
Athereal Elastic fluid whose vibrations give
the sensations of light. Some Diamonds shine
by being rubbed yet lose nothing from their
substance. I can make, says the Doctor, an
Electric fluid bright as a candle, yet I do not
suppose the Electric matter leaves the conductor.

Different

Different & weaker sparks produce different colours - the strongest white - the weakest red &c. For a further view of this subject I refer you to the Dr's Letters.

Notwithstanding these Authorities the Author of the above mentioned performance very positively asserts the opinion of Sir Isaac to be received with contempt by Philosophers - At least our Critic sh^d have produced his Authorities, but these are Anonymous to us, to him, & to the world - & I find no Author that ever doubted or attempted to contradict it.

There is no crime in not understanding an Author, but it is a great one to attack him without understanding him - Accordingly our Author is not only ignorant of my principles, but even of the manner in which Sir Isaac treated this opinion, and nothing is left but to conclude that he is grossly ignorant or has uttered a notorious falsehood. - I am happy that I am not in the situation of poor Galileo, thanks to this enlightened age than I am not otherwise I should have my mouth stop't for uttering Heresies in Philosophy.

Ther

Vid. Schol. Gen. at the end of his Elements.

The 2^d Assertion of our Critic is - That this subtle Elastic fluid is mere conjecture & that Sir Isaac himself was not convinced of the reality of the existence, either from observation or Experiment. I have proved this false, & tho' Sir Isaac delivers himself in conjectures concerning the application of this opinion, yet any person who reads the passage will immediately perceive that Sir Isaac was convinced of the opinion, & that from facts.

3^d Assertion. That he applied it to solve all the Phenomena he did not understand; but I maintain that he never applied it, on the contrary he only proposes it in a few modest queries - he said that the laws of this Ether collected were too few & insufficient to apply the doctrine concerning it to the explication of the several Phenomena.

What then shall we think of the Impudence of a grovelling Author who had the opportunity of reading this, & yet could call in question a Philosopher who was no less ingenious in finding out causes than cautious in applying his doctrines.

But



But the design of these Authors I am convinced was not so much to guard others against the opinion of Sir Isaac Newton as to throw out general abuse upon me. They have abused my doctrines in general, without candour, without being acquainted with my opinions or the principles they were founded upon - I am the hairbrained Professor who has got a fanatical set of Disciples.

It may be alledged indeed that I am not mentioned in the article & that, only Dr Brown's Thesis de Ortu Animalium Latoris. The Thesis is by no means ridiculous, but I think myself not under the least obligation to defend any part of it. I, as a Professor of Physiology, thought myself obliged to give you the Conjectures concerning the Nervous System - Haller has a paragraph de conjecturis.

What I have expressed as loose & undetermined concerning the Ortus Animalium Latoris, Dr Brown has delivered with an Air of confidence, which I could not approve of, & if it had been possible I sh^d have stopped, but the greatest part when
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I have commented upon it will not appear so ridiculous as the Authors of the Encyclopedia have imagined.

I desire you would cautiously receive & be wary in applying what I deliver concerning the Theory of the Nervous System. I thought proper to set out with telling you that the fundamental position was the Doctrine of Sir Isaac Newton, & the Physicians & Philosophers since his time have generally adopted it.

1.st Dr Mead. The Author of his life says the Dr in his youth thought he could explain the effects of poisons by their action on the blood, but afterwards he thought there was a subtle invisible æthereal fluid which served as a vehicle over which the poisons spread themselves. He considers the nervous fluid as highly subtle & elastic lodged in the brain & diffused over the Nerves, being a quantity of the universal æther that pervades all bodies. But this I mean says the Doctor that universal elastic fluid of Sir Isaac by whose vibrations heat light &c were produced. Neither Dr Mead nor the Author of his life knew that this was a rejected & exploded

exploded opinion, nor was Dr. Mead censured as absurd for adopting it.

Dr. Brown Langrish who read the chronic lectures takes it for granted in his 73^d Par. that Ether was the medium of the communication of motions - lodged in the brain, spinal marrow & nerves.

Dr. Hartly proceeds on this principle in explaining in whole Animal Economy - perhaps he may have failed in his general Application but no one has treated his fundamental proposition as absurd.

Dr. Bryan Robinson in his treatise on Sir Isaac's Ether, attempts to explain it's operation - Morgan attacked his Application, but agrees with him that there is an Ether.

Dr. Hayes supposed the conclusion inevitable.

Dr. Gaubius shews he strongly he is disposed to believe it.

The French Physiologists hold the same.

Mr. de Cat.

Mr. Camel. in his treatise of the Animal Economy - puisqu'il n'y a que l'Ether qui est le liquid active.

You will therefore from these great Authorities, see the illegality of my critical assertion - that either
my

my pupil or I wanted to revive exploded doctrines. But my commentators, gentlemen, are neither philosophically nor morally scrupulous, since they have attacked me both ignorantly & unjustly, and nothing can be more truly ridiculous, for men to attempt an explanation of the whole circle of sciences without a competent knowledge of the principles on which they are founded. The specimen on the Article of them warrants this assertion.

I shall next proceed to give my own arguments independent of any authority.

After a Disagreeable Preamble I proceed to my Theory of the Nervous System - a work of much difficulty & concerning which there are a variety of opinions. It is of an obscure nature nor can we expect to complete it. The disquisition is however necessary & has been esteemed so by every Physiologist for there are few of the most eminent that have not attempted it, and we shall have an opportunity at least of refuting their errors.

Theory

Theory of the Nervous System.

The 1st Proposition I would maintain is - That there is in the nervous system an Elastic power, and that the motions there consist in the vibrations of this power the same as in other Oscillatory Elasticities - I do not say whether this elastic is fluid or solid, at present I affirm that it is endued with Elasticity.

1st Argument in proof of this is - from the consideration of the communication of motions in general & the velocity with which such communications are made. Where motion is communicated from one body to another by the intervention of a third it must either be by the local motion of the whole mass or by the particles of the intervening body vibrating by means of an Elastic Oscillatory principle in it; thus I place 3 billiard balls separate from each other in a direct line - if I strike the 2^d with the 1st & this hits the 3^d it must be by the local motion of the intervening ball; but if I place 12 such balls in a line & in contact with each other, upon striking the first the last will fly off.

off while the intervening ten do not move their place, this is not by the local motion of the whole intervening mass but by the Elastic Oscillations communicated thro' the whole of these to the last Ball. We may consider our Nerves as the intervening mass where one extremity is first acted on & the oscillatory motions are communicated thro' them to the other extremity.

Some Physiologists have supposed the whole mass to be moved, I have illustrated it by a tube filled wth bullets so that by striking at one end the bullet flies out at the other, that you cannot move the one extremity of a fluid in a tube without moving the other extremity - this likewise they think accounts for its velocity, but this infers the supposition of absolutely rigid canals, for if they are not direct & rigid the communication from the one part of the fluid mass to the other may be impeded & may go off laterally not in the intended direction, the flexibility of the Canal may defeat the communication. The supposition likewise that there are small tubes without any contraction for the contained fluid is contrary to observation & experiment, for all fluids adhere & the adhesion encreases in proportion to the freq^t passage of the fluid thro' the tube,

so

so that tho' it might at first pass on yet the increase of adhesion at every transition of the fluid w^d prevent it's continuance. In capillary tubes we know there is a great attraction between the fluid & the tube, & the smaller the tube the greater is the attraction & therefore the supposition of rigid canals & fluids wanting attraction is contrary to every thing we know of the Animal System.

If motions are propagated along the Nerves & if we take any but the Stahl'sian supposition we shall find that motions cannot be communicated from one extremity to another but by means of Elasticity or an elastic oscillation. But it has been demonstrated by Mathematicians that the Velocity is in proportion to the Elasticity & rarity of the Medium taken together, & from the velocity with which motions are communicated in the Nervous System every Physiologist supposes a Nervous power; but I must say that this Velocity or quickness of communication in the Nervous System is not so clearly evinced, for the distance between the origin & extremity of a Nerve from any one part of the Nervous System to another is not so great but that the communication of motion may seem instantaneous to us who cannot mark very minute portions

of

of time. I think I cannot mark any time that is less than one third of a second, & therefore any motions performed in a shorter time than that must appear instantaneous. Many motions however are much more rapid. It is not from the contemplation of the short distance of time with which this communication of motion is performed that we determine the velocity, it must be from the velocity with which muscular power is performed. We suppose that the nervous power passes over a certain space in the alternate contraction & relaxation of muscles. Haller rejecting supposition calculates the velocity of the nervous power from experiment, & he says that the nervous power moves no less than 9000 feet in a minute; he does not mention the experiment but from other parts of his works we learn he did it from the consideration of the velocity with which muscular motion is performed - (Vid. 483. pages) he found that a man could pronounce 400 letters in a minute, & he numbers so many contractions & relaxations, for at every distinct articulation there is a relaxation & contraction of the muscular fibres, but in some letters, as the letter R, he supposes there are 10 vibrations - Upon this he calculates the contractions & relaxations of the

Styl. 10

Stylo Glosi muscles to be 30,000 times in a minute
which is 500 times in a second, but we want to de-
termine the space passed over by the nervous
power on every contraction and relaxation & this
will bring out the velocity of the nervous power
to be prodigiously great, but the matter is not to
be brought to a calculation - it is considerable
enough however to infer that the Elasticity &
rarity of the Medium must be very great & conse-
quently the velocity. Where we observe the velo-
city of the communication of motions propagated
thro' two bodies without the intervention of a third
we conclude it to be by elasticity where the motion
first impressed is much too small to move the
whole mass.

Dr Haller produces many instances to prove the
great mobility of the nervous power. He observes
that the rays of light proceeding from the Moon
is so weak that when collected in the strongest
Lenses do not shew the least degree of heat, yet this
acts on the retina & is sufficient to serve the pur-
poses of vision & enables us to discover objects
of great minuteness, & from the general consideration
of the rarity of the rays it is supposed that the
Nerves can be moved by very weak Impressions
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and he concludes with saying that nothing can account for this, but that the body impressed must be an extremely rare and elastic fluid. If this is not a demonstration it is at least a strong presumption for the presence of an Elastic fluid in the Nerves of Animals, but it can be supported by more direct proofs.

2. Most impulses acting on the Elastic Power are of the Oscillatory kind, as in the case of Sound & Tremors communicated from various bodies to ours, probably also in the cases of Sight, Odour, & in many of Touch.

I have endeavoured to render it probable that all communications of Motions are of the Oscillatory kind, but some impressions are only simple Percussions, but it is sufficient that Sounds, Tremors, &c are of this kind. If Sensation depends on Motions propagated from the extremity of the Nerves to their Origin then the motions communicated along the Nerves must be the same as the Impression, & this motion when made by an Oscillating body must give Oscillatory Vibrations, and an Elastic fluid can be the only proper Vehicle for such Communication, but it may be a simple local motion of the whole mass, as we cannot say
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with what motions Sensation is connected, and we cannot conclude from the nature of the Impression as to the nature of the motion communicated in the Nerves. But the Sensation is in many cases corresponding to the states of Oscillation in the impressing body, as in the different tones of sound which are different according to the Vibrations.

But that the motions are of the Oscillatory kind we conclude from the extraordinary power Oscillation has in the motion of our Nerves - A slight motion of a feather is capable of agitating our System violently, and from the considerations of the effect that slight Impressions have in exciting violent motions I find a stronger proof to me of the slowness of Impressions produced in our System than any Dr. Haller has given, and the communication of motion by a slight Impression is a proof that the motions are communicated by an Oscillatory Elastic.

More direct proofs of this.

When the tremors in the Air or other bodies excite tremors in us, for our body is very often in union with the tremors of the surrounding bodies, and as these tremors act only upon the soft parts it

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vid. Haw. Impetuum faciens.

can only be by the intervention of an Elastic power. Shaw Boerhaave after losing his hearing had Sensations of that kind from Elastic Oscillations & acquired a sensibility from the tremors of sound exciting tremulous motions in his Nerves communicated by an oscillatory Elastic, and from this foundation of the vibrating motions of surrounding bodies, exciting Sensation in the Nerves, Dr Hales concludes in his Hemastatics. It has been observed when a part has been scratched by a nail a pungent Sensation has been felt in a distant part (vide Hales Page 50.) - as in the shoulder here is a direct communication of Oscillatory vibrations, & which he says gives a great supposition of the great energy of the Nervous power contained within or adhering without the Nerves - This activity & energy is a proof to him of an Elastic fluid, & the Energy & Activity are nothing but its rarity and elasticity.

But if it should be found that motions produced in our Nerves do subsist after the impressing power is removed, it can only subsist in consequence of Oscillations remaining on the Elastic power.

Sir Isaac Newton at the end of his Optics says there is sufficient proof of an Elastic power in the Nerves of Animals - & M. Boisson's Experiments are a further

further proof. When our Eyes are exposed to the direct Sun in the Evening for some time, he found that by turning them off to a white wall he saw a variety of colours which must have been produced by vibrations remaining in the Eye from the impression made by the light of the Sun. I shall mention another Author, the ingenious Dr. Franklin, in a letter of his concerning Scotch Music, where he says that colours being left in the Eye when the light is shut out gives a sufficient proof of a vibratory motion remaining, i.e. still continuing to oscillate after the Impression has ceased to act, & possibly the Vibrations given to the Auditory Nerve may remain when the exciting cause has ceased. From all these circumstances we conclude that there is a vibratory motion in our Nerves & consequently there is an elastic power.

There are many of the Phenomena of the action of the Nervous & Muscular fibre that depend on tension. This I have often mentioned. The Vibratility & Mobile state of the Nerves depend on their state of tension, & this Inflammation by increasing this increases their Sensibility. Dr. Haller when speaking of the different effects of Strictures observes that

that when the Nerves are more stretched the effects are greater than in their relaxed state. All these Arguments taken together support one another & prove to me an Elastic power in the Nerves of Animals. These Phenomena have determined Physiologists in all ages to infer an Elasticity in the Nerves, but they imagined it to be the Elasticity of a Solid like Catgut, but to this opinion there are many insuperable objections, & the Supposition of a Solid Elasticity is now universally renounced. I refer you for further Information to Haller's 4 Vol. pag. 358-361— where he refutes this opinion, and therefore we conclude that if there is a proof of an Elastic power in the Nerves it must be the Elasticity of a fluid.

Having thus established the fundamental proposition that there is an Elastic power in the Nerves, we may proceed from the Phenomena to determine the several laws of it— to enquire what is the nature of this fluid Elasticity, whether it is Air, light Ether, or a matter common to a great part of nature, or whether it is a matter sui generis peculiar to the Nerves— whence it is derived and where received, & how occasionally supplied & continued, but these perhaps may not be very necessary to investigate.— As many of you however will not
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rest here satisfied, I think it necessary to accompany you as far as the resolution of these questions can be with probability attained.

In attempting the Theory of the Nervous System I proceeded with the utmost caution— I first mentioned the propositions I thought of most importance, & which most clearly admitted of proof— that there is an elastic power in the nerves of animals, and that this is an elastic fluid. These are at present propositions generally received; to exercise you in this I refer you to two Writers, Haller, & Senac's commentary on Meisler's Anatomy. This reference is certainly fair as their conclusions do not coincide with mine. I recommend you to all Haller has said in his Elementa Physiologiae. When you consider these writers, tho' they hesitate in making any ^{certain} conclusions, yet you will see all the Arguments in favour of our opinion, and this being established many questions may occur with regard to this fluid in our nerves— Many of these are perhaps more curious than useful, & I am not obliged to obviate every difficulty that may occur; thus Haller hesitates considerably in admitting this fluid to be analogous to any other we find in nature, because we cannot conceive how such a fluid can be confined in
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the Nerves - this difficulty I cannot remove, but it does not imply a contradiction in terms - I admit the fact as he states it, but it proceeds on two suppositions by no means necessary to be admitted, that considering its great rarity & subtilty it is difficult to conceive how it sh^d be conveyed & adhere to the porous bodies of Animals, & how it sh^d be confined in any kind of Canals - this if admitted would be a considerable difficulty, but the supposition of a fluid confined in vessels is by no means necessary to explain the Phenomena. - Not to mention the various processes in nature that we have not the least conception of, we have an argument from the analogy of the Electrical fluid, that it passes along the nerves without being confined. The Phenomena of Electricity depend on a fluid matter surrounding & adhering to bodies & not confined in vessels, and although it can penetrate the densest bodies, yet when accumulated in a vial is confined & retained by the glass, and so extremely subtle that if there is the most minute & imperceptible crack in the charging vessel it will escape like water thro' a sieve, tho' at other times it penetrates glass with the greatest facility. This is no doubt a difficult and inconceivable problem but yet it does not over-
-throw

throw the notion of the existence of the Electrical fluid.—

We cannot pretend to account whence the Nervous fluid is derived—what is its nature— or, how it is confined. Yet our inability to solve every objection can have no influence in rejecting the proofs we have alledged in favour of the Nervous fluid. On this fact I might refuse to go further in Theory, for many imagine whilst difficulties remain in any part the whole is groundless & fictitious.

Some Gentlemen will enter into no Theory, whilst others set no bounds to their enquiries, & aim at a solution of almost every Phenomenon. The latter I shall in a certain way accompany, & shall shew what limits are to be made to the prosecution of this study.

It has been supposed that the Nervous fluid is the effect of a secretion in the Brain— an incorporeal matter separated in that Organ & lodged in the Nerves.— We differ from this as to the manner of its production; it is neither the effect of secretion or of any analogous process— it is something more general in nature, & constantly inherent in the Nerves— uniform in quantity, neither wanting occasional supply or being liable to

to occasional waste. This last conclusion if established will be the most important Theory, and now I lay the whole before you at one view.

1. There are many proofs of a secretion made in the Brain.

A large proportion of Blood is distributed there. The extremities of the Vessels proceed to the utmost subtilty of Division, and this is very universally applied to the purposes of Secretion.

There being no appearance of Glands in the Brain is no objection, but we want the evidence of the secreted fluid & the excretories by which it is poured out.

The theory of the Nervous fluid has been esteemed defective, because we cannot by intumescence demonstrate the descent of it in the Nerves, neither can we by a ligature produce intumescence in Vegetables, yet every one is convinced of the existence of their fluids.

It is highly probably that Nutrition is performed by the Nerves, by fluids propagated along the Nerves supporting the System, and therefore it is probable there is a secretion in the Brain.

I find from many considerations that for the purposes of Nutrition a fluid of an aqueous albuminous

menous nature is required, and there are the same proofs of such being the nature of that fluid as that Nutrition is performed by the Nerves. But if such is the nature of such fluid it cannot be the same with the subtle oscillatory ^{elastic} fluid we have spoken of. I therefore distinguish two kinds of fluids in the nerves

- I. The Elastic which is the Instrument of Sense & Motion.
- II. The Nutritious secreted fluid.

The former I call the Nervous - the latter the Nutritious fluid.

Formerly it was supposed that the same fluid answered both purposes, by supposing the nutritious fluid to be in a state of vapour; but this opinion is rejected, as an aqueous fluid tho' in a state of vapour is not reconcilable with the several Phenomena of the Nervous system.

From there being a secreted fluid in the brain many Physiologists have imagined a similar process for the production of the Nervous fluid - but the difference of function contradicts the notion of Analogous, & the different nature of the fluids to say nothing of other considerations, render this opinion upon the whole highly improbable.

We know nothing of the nature of the blood that

that renders it fit for the secretion of such a fluid - it is not impossible but the blood may separate it, but the opinion is merely hypothetical.

If you suppose the Elastic fluid to be secreted, the most obvious opinion is that it is confined in canals contiguous to the extremities of the Arteries, but this is totally groundless and improbable.

From this hint however I will add one further consideration, & here must introduce a probable circumstance tho' by no means conclusive - that if there is a fluid confined in canals contiguous to the extremities of Arteries it must be the nutritious fluid, but the Elastic fluid adheres to the Nerves in another manner, this however involves the supposition of a fluid adhering & not confined in hollow tubes, and to this opinion I shall rather give the preference.

Dr Hales does not think it necessary to determine whether this fluid is conveyed within or without the Nerves, but he rather supposes the latter.

So far therefore the Doctrine of a fluid secreted serving as the Instrument of Sense and Motion is Hypothetical & it infers a locomotion of the whole mass from the Origin to the extremities of the

the nerves.

2. It must be constantly wasting at the ends of the nerves, for no one pretends to show how it is returned again into the system by any thing similar to a circulation.

3. It must need a constant supply.

It is in consequence of the supposition of a secreted fluid that physiologists have said that a certain quantity of this fluid entered the muscles & was necessary to their contraction. & in consequence of this contraction the fluid was exhausted.

There is no proof of a locomotion of the nervous fluid, that the fluid passes from one part of the nerves to the Brain & from the Brain to the nerves resembling circulation, as the supposition of it's being an elastic fluid supercedes the necessity of a local motion.

Mr Senac obviates the difficulty of a local motion by saying it is an elastic fluid - that small motions in the one extremity produced motions in more distant parts - but the proofs he brings are not satisfactory, they are founded on Reports made on the Phrenic Nerve - we know as the Report was first given, if the ~~same~~ Phrenic Nerve was compressed it stop'd the motion of the Diaphragm.

Diaphragm, but on striking it or pressing it down you promoted the action of the Nervous fluid, & Muscular contraction was excited. This however is a mistake & Haller has made Experiments that actually contradict it—(Vide Hall. Accounts of Expts. on the Phrenic Nerve. 568. of his opera minora. Ch. 174. 175. Page 366. Vol. 1^o.)

This is sufficient to destroy the whole credit of the Experiment. Senac has taken pains on this subject, & in his 659 pag. on Meis. Anat. says If the Nerves cannot act like the Chords of Instruments there remains no other action but by fluids passing thro' their Cavities—this is proved by the Expt he says on the Phrenic Nerve.

Ligatures intercept the communication of the Nervous fluid—below the ligature it is still entire—make the Experiment on nerves cut out of the body, and then consider how far such can be possessed of a locomotive power.

Contractions will be equally excited whether you apply the puncture near the Diaphragm or at a distance—but if it depended on the quantity of the Nervous fluid the force of Contraction would depend on the length of the Nerve and the place of puncture because the longer the Nerve is

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Hall. op. min. Sep. 140.

and the more distant the puncture is, the greater quantity of fluid will be sent into the muscle, & hence a stronger contraction.

If we consider that slight impressions cannot be supposed to give locomotion to the whole mass, we shall then see that all the experiments made on cutting the nerves are against the supposition of locomotion, & in favour of an inherent elastic power.

But the strongest Argument against Secretion & consequently against local motion - is the Duration with which the Nervous power remains after the communication with the secretory organ is cut off. I refer you to Haller in 358 page of his Opera Minora, where he shows the duration of irritability after the communication with the brain was cut off, & hence infers the inherent power of muscles to be independant of the brain. - I say that the Nervous power & vis insita of Haller are the same, & every Argument he has brought in support of the one will apply to the other. Locomotion must necessarily include the supposition of a constant waste, and consequently an immediate supply; but for a refutation of this I must refer you to Haller's Reports on the duration of Irritability, where he says an animal lived 20 days after

after the Sciatic Nerve was tied, & Muscular contraction remained. In Expt. 141. an Animal lived longer & ran away from him. Here then are instances of the long subsistence of the Inherent power in Animals much longer than we can reconcile with the view of Secretion & its concomitant circumstances of waste & supply. In the case of Palsy which often subsists for years, & which depends on the interruption of communication between the part & the brain we find the Muscles have not lost their irritability, & the inherent power so far remains as to be excited by Electricity, this therefore it is evident must be incompatible with the notion of a secreted fluid possessing local motion.

If the Elastic power is confined in canals, this necessarily supposes a local motion & no cause of adhesion; if we suppose it to be the nutritious fluid it must quickly escape from parts of the nervous system that are wounded & cut off from all communication with the brain.

If a Nerve is cut into 100 pieces in every piece the inherent power shall remain in vigour & can be excited by Stimuli for many days - but if an Elastic fluid is confined in canals it must immediately

ately escape from an excision of the canal, and consequently can have no duration of its inherent power. Therefore that Muscular Contraction is performed by means of fluids poured into the muscles is highly improbable, & numerous Experiments prove the confinement of the Nervous fluid in hollow tubes to be incompatible with the Phenomena, and I add that the explanation of the doctrine of Contraction is attended with very perplexing difficulties, & the alternate effect of relaxation is still more embarrassing, for if a quantity of fluid enters the muscle at every contraction this must necessarily infer the egress of that quantity at every relaxation.

If the Contraction of a muscle depends on an accessory quantity of the Nervous fluid sent into it, its relaxation must depend on this accessory quantity leaving the muscle - but in what manner this is disposed of no Expts have hitherto shown.

I have shewn that the common account of the Experiments made on the Phrenic Nerve will only apply to the communication of motion. The notion of secretion & progressive motion must of consequence exclude every supposition of adhesion because

because it would be an impediment to the quick propagation of motions. We observed the Impossibility of it's being confined in hollow tubes, for upon the least excision so elastic a substance must immediately ~~escape~~, the contrary of which is evident from the duration of Irritability. Slight impressions are able to excite as violent motions as the strongest we can apply, & this Argument is of considerable force against the notion of progressive motions, but is much in favour of the communication of motions.

The quantity of the fluid necessary to contraction sh^d not [on their supposition] be so great, nor of course the contraction so strong when you prick the Muscle as when you prick the Nerve; or if you irritate the Nerve at a smaller or greater distance from the Muscle; but from undoubted Experiments the effects are alike & no difference appears as to the remoteness or contiguity of the place of puncture. A fluid in it's nature mobile & elastic sh^d fly off *qua patet exitus*, & if it has no adhesion to the sides of the tube it sh^d not remain long after the Nerve is cut thro', but it does for a space of time that is utterly incompatible with

with such a supposition.

I have given proofs from Haller of the permanence of Irritability when the nervous fluid was abstracted, this obtains for a considerable time in Animals and still longer in the various Amphibia, but from our notions of waste & supply any deficiency or waste must be immediately made up - but we know it subsists long without any supply, differently permanent, according to the temperature of various Animals. The temperature of Amphibia we know to be less than Air, & the cessation of Irritability after two or three days we may impute to the loss of temperature flexibility &c., for was it not for a diminution of heat they might possibly subsist for a much longer period. Therefore Physiologists that maintain the opinion of a secreted fluid must take in some singular power of adhesion, for otherwise they could not explain the Phenomena.

The circumstances of the ingress & egress of the fluid at every contraction & relaxation has as yet been explained by no Physiologists. Haller in Pag. 561 of his fourth Vol. gives all the different Hypotheses that have been started on this subject and rejects them all as inconsistent with analogy and

and Anatomical facts. He supposes the Nervous fluid enters the Muscles & after remaining a certain time is changed to a fixed nature and adheres to his Gluten, but this is as gratuitous supposition as any he has rejected, & is on many accounts inadmissible; from hence he explains how muscles increase in bulk from this additional quantity of matter deduced from repeated contractions & from the viscosity of his Gluten - but if this was the case how large must the heart grow whose contractions subsist during the whole of life - if this was to increase in any degree at every contraction we should find it to be considerably larger than it is. But the increase of bulk is entirely owing to the distension & elongation of vessels with the addition of cellular texture, and these causes ceasing in old age the parts gradually diminish.

But to me it is very extraordinary that Haller did not find another explanation from his own Theory. He says that the *Vis Nervea* does not give an additional quantity of matter, but only stimulates or puts in action the *Vis insita*. This doctrine of the Inherent power leads to the supposition of a power constantly present, and every Phenomenon whatever proves that it is a communication

communication of motions from the velocity with which the motions are produced, & any how a motion excited serves to induce contraction analogous to his doctrine of Stimulus - there needs no additional matter to account for contraction merely the motions excited are sufficient, no one can conceive that the point of a needle adds any thing.

On withdrawing the Stimulus the motions cease & relaxation as instantly takes place as contraction had done before on the irritation applied.

Relaxation then depends on the inherent power & contraction on the communication of motion, the former being only a cessation of the action of the inherent power, & the latter the motion of it. Upon the whole the Phenomena of sense and motion are agreeable to our opinion of a fluid inherent in the medullary substance of our nerves & we therefore reject the occasional supply of matter by secretion. Hence I conclude the Vis Nervea is not a secreted fluid but an inherent one, & we shall hereafter render this notion of an inherent fluid more agreeable & analogous to the operations of nature. Dr Mead is inconsistent in his account of the Nervous fluid - he considers

considers it as a part of that universal Elastic matter that is diffused every where throughout the universe; that it is incorporated with the blood and from thence separated by the Brain & lodged in that organ; but if it is universal it is present every where and it's adherence must depend on a particular state or modification of matter. I give a further Argument why it is an inherent power and not a secreted fluid.

Watching & Sleep are incompatible with a secretion. Watching is often prolonged when the body is much wasted, & Sleep occurs when there has been no exhausting. The periodical return of Sleep & watching that we before took notice of render this opinion highly improbable - the returns of excretion & appetite which are in some measure periodical seem at first view to favour this opinion, but they return under considerable vicissitudes & are only rendered uniform as to time by habit & are totally independant of this circumstance - we may therefore conclude that Sleep and watching must depend on a law of the Nervous fluid independant of secretion. It is the phenomena of Sleep and watching that have afforded Physiologists the

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chief Arguments for a secreted fluid - these I have rendered incompatible with their doctrine, & from a consideration of all the Phenomena attending Sleep & Watching it appears that they depend much more on the difference of mobility than on the quantity of the Nervous fluid, & if we admit this it will be sufficient without having recourse to any variation in quantity, and therefore the considerations of Sleep and Watching are to me among the chief proofs of the nonexistence of a secreted fluid concerned in these functions. The effects of Heat & Cold in the Nervous System are consistent with the presence of an Elastic fluid as dependant on these effects.

We find the inherent power is established in Animals before there can be any supposition of a secretion; that it exists previous to the blood vessels & before the heart & arteries can act to produce a secretion. In parts cut out from the rest of the System the inherent power is independent of any waste or supply of matter, and manifestly shews no need of secretion.

Thus then we have established two great & important propositions in the Nervous System.

1. That there is an elastic fluid in the Nerves.

2. That

2. That this fluid is inherent in the nerves & is not liable to occasional variations of its quantity.

You will see that I have made considerable variations in my system from that of others—different from Boerhaave & all other Physiologists by maintaining that it is inherent in the nerves. Dr Gaubius is the only Physiologist that has hinted a suspicion of it. He says it is a matter connected with the nature of the medullary substance & co-existent with that mass in the first formation of Animals (*ab ortu indita*). Gaubius his private sentiments I am persuaded are more explicit & would come much nearer to our opinion—but we find it extremely difficult for Men to quit their favourite Systems—accordingly Gaubius ~~has~~ has thrown out the expression *sugae*—which is totally inconsistent with what he said before & can only apply to the other Systems of Physiologists that we have refuted. I could give many instances of persons hesitating to go farther upon a well founded opinion, but have dropt it merely from an attachment to ancient prejudices. Dr. Mead adopted the supposition of an Elastic fluid, but
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he could not quit the notion of a secretion by the Brain - Mr Senac in like manner.

But the most remarkable instance of this is, the hesitations of Dr Haller, who adduces all his Arguments that it is tenuissimum & mobilissimum, but dares not conclude it he is so fettered by his opinions in the other parts of his System. He thinks it must be confined in Canals but does not reflect that it may be conveyed within or without these - he thinks it must be a gross fluid because it is intercepted by a ligature, but the ligature prevents the communication of motion - he thinks it must be supplied by meat & drink. - I shall examine this last objection of Haller's, as I suspect this to be a principal objection of Dr Gaubius. I find no sort of difficulty in this objection. The want of Meat & drink indeed makes the nervous power languid, as the contrary or enough of meat & drink gives vigour to the nervous power, but this is no proof of the nervous fluid being supplied from this source.

The Nervous power depends on the state of the System & for it's excitement to proper action
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it depends on meat & drink - but no further than meat & drink are necessary to the Economy to give a sufficient quantity of fluids, & hence the due degree of tension is necessary to the proper state of the Nervous power, but the effects of meat & drink invigorating or causing a languor are no proofs of their acting by increasing the quantity of matter. No one can suppose that the quantity of blood entering the muscles is necessary to furnish the matter of contraction, but only gives the state of proper tension to the muscles. The Nervous power depends upon impulse and tension & these on meat & drink, but meat & drink do not supply the matter of the Nervous fluid. - Meat & Drink are necessary for heat, hence the only proverb - sine Cerere & Baccho friget Venus - is true with regard to the general system. Meat & Drink therefore act only by increasing the generating powers of heat, & not by supplying the matter of Heat.

The vigour of the Nervous power depends as much ~~more~~ ^{on} external impressions as on Meat & drink - its vigour depends on external impressions

sions constantly applied, but no one imagines that the various supply of Impressions give a supply of the Nervous power - the tremors of the Air, the point of a needle &c. cannot be supposed to supply the Nervous power.

Mr. Lieutaud gave us formerly an *Elementa Physiologiae* & in his 3^d Sect. he gives a definition of the Latex Nerveus, *substantia Aetherea* &c. but he could not get quit of the supposition of a secretion of the brain, but he says there is no room for the action of secretory or excretory Vessels, but that this secretion is performed by an apparatus totally different from any we know in nature. But when he has thus procured a secretion by very singular powers he is puzzled how to keep it in the Nerves, but he says it is detained there by Magnetism, a term w^{ch} natural Philosophers use, & which signifies no more than attraction.

Thus you see that ~~at~~ length they are forced to come into our notions, & if hitherto in maintaining these propositions I have removed many difficulties that attended them, I am under a necessity, in order to establish them firmly, to remove more.

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An inherent fluid is what we do not well understand and which I am unable to explain — The fact is highly probable & I admit it — & if thus established it is not necessary that I should account for all the difficulties concerning it as there is nothing contradictory in the supposition. However in our next Lecture we shall proceed to examine what light analogy will throw upon this subject.

I shall now give all that I think absolutely necessary on this subject. What I have delivered perhaps does not go so far, but yet puts us in a train of Investigation very different from that of former Physiologists. What I have said is concentrated in two propositions.

1. The existence of an Elastic fluid in the Nerves of Animals performing the Offices of Sense & Motion. This I have clearly established & is now as generally received opinion, & I flatter myself that the Physiologists of the 19th Century will receive it universally.

2. That this Elastic fluid is inherent in the Medullary Substance of the Nervous System. This is clearly the present opinion of Physicians & almost as well supported as the other — it is evident that the

the Elastic power adheres strongly, & that even when destroyed it is more by changing it's quality as it is inherent than by any variation in it's quantity - for if a Nerve be ever so minutely divided, & of consequence cut off from all communication with the brain it still communicates motions - hence we conclude it to be inherent, & if it is inherent it cannot be a secreted fluid which necessarily supposes local motion.

What are the Laws of this inherent Elastic fluid? These I have before enumerated, but I shall proceed farther to satisfy those whose enquiries cannot be limited till every difficulty is removed. We shall now therefore enquire how these are supported by analogy.

Illustration by Analogy.

I. There are many Phenomena in Nature performed by subtle Elastic fluids.

1. Magnetism or the Magnetic fluid.

This is a subtle fluid that pervades glass & gold & every other matter that is not Magnetical or in a state of red heat - it is universally present in our terraqueous system, for we can give Iron a Magnetic

magnetical quality without the influence of any thing but Earth. From its Polarity & other Phenomena attending it, it is what Philosophers term a cosmic quality - a matter in nature diffused over the whole of our Earth. The Aurora Borealis tho' at such an immense distance has great influence on the Magnetical qualities of bodies, it is every where present & is a particular modification of the universal Ether.

2. The Electric Fluid.

How Subtile & Elastic this is I need not attempt to prove, it adheres & is communicable from one body to another. Heat is a powerful Elastic, a subtile pervading universal fluid. We know of no portion of matter that is in it's utmost degree of Condensation, and if it is expanded it must be imputed to the powers of heat acting in it's pores. With regard to the nature of heat there are different opinions.

Whether Heat is an Elementary quality formed of the parts of the different mixts we have considered - or whether it is a body in common to all - this enquiry would be unnecessary for us to pursue, every body allows the obvious properties of heat and that is sufficient for our conclusions.

147

4th Evidence of an Elastic fluid is Light, concerning which there are two opinions.

1. If it consists in the vibrations of a fluid that fluid must certainly be universal in the whole system of nature extending between us & the Sun & the whole fixed Stars.

2. If it be an emanation from the Sun & Stars & if we consider the number of these rays that are continually emitted, the whole expanse must be filled with a subtile fluid. From the Phenomena of light falling on bodies & passing thro' their pores we have a proof of an universal fluid surrounding & contained in all bodies.

Light is reflected from bodies without impugning their solid parts. — In other circumstances it passes thro' them, but is constantly changed & bent in passing, when it is refracted, and this bending is performed at a distance from the surface. The same light in passing by the edges of sharp bodies is inflected, & this inflection is varied as the light passes nearer or farther from the edges of such bodies.

4. The rays of Light in arriving at the surface of pellucid bodies are transmitted & refracted.

5. Rays that have passed thro' pellucid bodies,

& pass into a vacuum on the other side, in this case light is reflected as if it fell on tin foil or any other opaque solid bodies.

If motion is only communicated by the contact of one body to another there must be a matter contained in the pores of solids that gives occasion to the Phenomena of reflection & refraction.

This is evident & amounts to a demonstration that there is a subtle Elastic fluid on the surfaces & contained in the pores of all bodies. These phenomena therefore evince us of the presence of another subtle & elastic fluid.

All these subtle & elastic fluids, heat, light, Electricity, Magnetism &c. establish the existence of a subtle Elastic fluid in the Nervous system of Animals. And the various Phenomena may arise either from a variety of these Elastic fluids connected with particular portions of matter, or from one universal matter liable to different Modifications from the state of matter to which it is connected. Both these equally apply to the Elastic fluid in the Nerves of Animals, but I own from a general view of the simplicity of the operations of nature

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I am led to think it is rather a modification of the universal matter. I think the presumptive proofs of it's being a common matter are worth our consideration.

1. We have reason to presume that the matter of magnetism & Electricity are one & the same. Mr. Erasmus of Petersburg who has published a *Leontamen Theor. Magnet. & Electric.* illustrates the one by the other & says they are governed by laws in common to each, & therefore we may suppose the fluid which causes them is the same differently modified in it's operations from it's union with different matter.

Electricity & heat have great affinity. Heat accumulates Electricity & in many cases will excite Electrics without attrition, & attrition produces heat & excites Electrics. — Electricity shews the phenomena of heat & light & philosophers use the term fire to Electricity, commonly denominated it the Electric fire. Heat & Light are certainly the same. If light consists in emanations from bodies it will be an emanation of that particular body which is lodged in the pores of bodies & which gives the phenomena of heat. If we consider it as vibrated from
bodies

bodies as the Sun &c light must consist in such vibrations as connected with heat, & heat & light must be supposed to be different vibrations of the same elastic fluid.

Heat & Cohesion have an affinity.

The state of Cohesion must depend on the state of this fluid in the pores of bodies which is so much affected by heat, & if there is an elastic fluid in the Nerves of Animals it is much connected with heat to wh it owes its first Decrement. From this consideration of the affinity of these various fluids we may presume that there is in nature one common elastic fluid wh is different as modified by different states of other matter. The term Aether is applied to this universal matter, & of late called Sir Isaac Newton's Aether, because tho' the notion was started long before he gave the world the most certain proofs of its existence, and this term sh^d only be applied to the general fluid not to the different modifications of it in Magnetism, Electricity &c

What Idea can we have of the Modification of this fluid in the Nerves of Animals, from the states
of

of the matter it is connected with - to resolve this we must continue our analogy still farther. - Fluids in other parts of matter may be under peculiar modifications; thus Magnetism depends on Iron in a peculiar condition & only when in its metallic state. Iron corroded by Acids or calcined exhibits none of the Magnetical qualities. Soft Iron can never become properly magnetized, & Steel only of a particular temper is proper for this purpose.

Some Iron ores as Hematites shew no Magnetical qualities, ^{but} if the Hematites is lodged in the neighbourhood of a certain Pyrites it becomes equally magnetical with the other Ores of Iron. These are curious facts & shew the connections of the universal Ether with particular matters & its modification in consequence of that connection. We shall pursue another analogy from the state of Electricity. This we understand chiefly from the discovery of certain bodies that allow this fluid to pass along them, & from others that arrest it in its passage & accumulate it. This property of conducting or not conducting

is connected with a peculiar arrangement of the particles of matter. Every elastic fluid conducts, but every dry solid (the metallic substances excepted) does not conduct. This property of liquids generally conducting, & all dry solids (M. S. excepted) not conducting is very general & the reason must be imputed to a variation in the state of the matter. Water in its fluid form is an excellent conductor, but on its change to solidity in the state of Ice becomes equally incapable of conducting as glass & other Electrics. - Wax, Sulphur, & Amber in their solid state are Electrics & accumulants, but if dissolved by the assistance of heat they become conductors. - Green Wood conducts but wood deprived of its moisture & dried does not conduct - it is merely the consistence of bodies that determines the whole phenomena of Electricity - (the M. S. are an exception to this) - but this when calcined or vitrified become non conductors, so that the conclusion is very general. The Modifications of Electricity depend so much on the particular state of other bodies that we may suppose it an universal

-versal fluid always dependant on the peculiar state of the matter in which it is found.

Light is a fluid present in all bodies, if it is the cause of Cohesion the Attractions of Chemistry which shew so many Modifications are all various operations of the same fluid. If there is a fluid on which Cohesion depends which fluid is denser on the surfaces of bodies than in their Pores, then this fluid must press more on the particles of the surface and must be a means of their greater Cohesion, & the state of Cohesion must depend on the state of density of the fluid on their surfaces, for light is most reflected near the surface of the densest bodies, and bodies reflect this fluid in a ratio of their densities. Heat depends on the vibrations of this fluid excited in the pores of bodies.

Other then we see may be modified by the state of the matter to which it is connected. This perhaps leads to Eulers system which Mr. Hearnly first started that there is in Nature only two kinds of matter.

1. in which bodies gravitate to the quantity of
which

which matter gravity is always proportioned.

2. The Inactive which only serves as a center to the other kind of matter, & thereby modifying the operations of it.

Ruler has brought strong Arguments to prove that each of the particles of the gravitating matter are precisely of the same density, but I go further and say that they are precisely the same in form & size, and that they are modified from the state of Matter within them— Our conclusion from what has been said is

That there is in Nature an universal Subtile Elastic matter which by its connection with other matter is variously modified, exhibits different Phenomena & is under different laws— in consequence of which Magnetism, Electricity, Light, Heat, &c are produced— and there may be a peculiar Elastic fluid in the Nervous medullary Solid, variously affected by the surrounding matter, and on which supposition we explain all the Phenomena of Sense & Motion.

The fundamental parts of Animals are present

sent in their peculiar germs, & every part in the Animal Economy is previously existent in the Germs - by the power of heat the fluid can have it's Elasticity excited, so as to admit of Oscillations from one part to another, and this depends on the peculiar construction of the matter & it's Modification by Heat. Where the circumstances of heat and this matter are given the Elastic fluid in the Nerves is produced being a Modification by these of the Universal Aethereal fluid.

End of the second Volume.

